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TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 385
Steel Arch Bridge over the River Spree, Near Berlin, Germany (illustrated) 386
Tunneling by Machinery on the Canadian Pacific Railway 386
A System of Signaling for Railways (illustrated).. 387
Underwood Statistics for Gas and Electric Lighting Companies 391
Interesting Illuminating and Fuel Gas Under High Pressures 391
Inexpensive Percussive Tool (illustrated)..... 395
The Latest American Railway Engineers' Manual... 397
The Swing Span of Duyvil Swing Bridge; New York Central & Hudson River R. R. (with two-page plate and other illustrations) 397
Technical Education in Iron Founding..... 398
Annual Convention of the American Foundrymen's Association 400
EDITORIAL NOTES 392
The Latest Fallacy of Liquid Air Promoters—Methods of the Berlin Fire Department—The Swedish Government Statistics of Commerce.
EDITORIAL:
Uniform Accounting a Prerequisite to National Municipal Statistics. 393
LETTERS TO THE EDITOR 394
The Manufacture of Portland Cement from Blast Furnace Slag—Determination of Tangent Bearings, New Croton Aqueduct Survey—Stray Notes of Travel (Editorial Correspondence).

SOUNDINGS AT THE AUSTIN DAM show that the main part of the portion washed away was carried out clear down to the base, leaving none of the foundation course, and that some of the rock on which the dam rested was cut out and carried down stream. The soundings in question were made last Saturday (June 9) by Prof. T. U. Taylor, who contributed the accounts of the failure published in our issues of April 19 and May 10, 1900, and the article on the leaks in the dam and the silting up of the reservoir in our issue of Feb. 22, 1900. The crest of the portion carried down stream and still standing there is 4 ft. below the original crest level, 52.1 ft. above the present water level and 60.1 ft. above its resting place. The length of the gap in the dam is 552 ft. at the crest, or 50.6% of the total length of the overfall, which was 1,091 ft. The discharge of the river is now passing through the space between the western, standing portion of the dam and the detached mass, silt sloping upwards from the latter to the power house end of the dam. From the silt level at the power house end to the water level at the further, or western, end, the gap measures 483 ft., or 44.3% of the length of the overfall. Further details of the results of the soundings, contributed to us by Professor Taylor, will appear in our next issue, having been received too late for insertion in full in this impression.

THE TRACK ELEVATION of the lines of the Pittsburg, Fort Wayne & Chicago Ry. and the Chicago & Western Indiana R. R., in Chicago, from 18th St. to 55th St. and 73d St., respectively; and of the Chicago & Northwestern Ry., Chicago, Milwaukee & St. Paul Ry. and Pittsburg, Cincinnati, Chicago & St. Louis Ry. in Kinzie St., from Ada St. to Kedzie Ave., from Western Ave. to Grand Ave., and from Ada St. westward, respectively, has received a serious setback, through the failure of the council to pass the ordinance for the latter three lines, which would be in close relation with the first two. The reason assigned is that the ordinance gives over a part of Rockwell St., already occupied by surface tracks, to the railways, although the railways were to provide land for a new street parallel with this on the other side of the right of way. It is publicly charged, however, that the ordinance was beaten because the railway companies refused to offer the aldermen any remuneration for its passage. The "Tribune" says: "An analysis of the vote shows that with hardly an exception every alderman who in private conversation or in public print has ever been accused of misconduct as an official voted against the ordinance. With them, of course, were some aldermen who have good reputations." These pieces of work were referred to in the articles on "Track Elevation in Chicago," in our issues of Jan. 11 and Feb. 22, 1900.

THE RAILWAYS OF GREECE are reported upon by the French Minister to Athens, in the "Moniteur Officiel du Commerce" for April 26. He says the first railway was opened in 1869, between Athens and its port, the Piræus. There are now about 600 miles of railway in Greece, operated by four companies. The longest line connects Athens with Pyrgos and Olympia, on the Ionian Sea. It is said that an Anglo-French syndicate has taken up the old project of building a railway from the Piræus to Larissa, in the extreme north of Continental Greece, and from there connecting with the Turkish railway system. The line would be 212 miles long, and the estimated cost is about $7,000,000. This line would connect Athens by rail with Europe.

THE CENTER AISLE ON ENGLISH RAILWAY TRAINS has recently been introduced on the Great Western Railway, and the time-honored separate compartment system is practically abolished. The partitions between the seats in no case rise to the roof of the car; and in the first-class carriages the passengers are seated two on a seat on each side of the longitudinal center passageway. The cars are entered from the ends, and another innovation is the use of inside signal cords, running along both sides of the car near the roof. The railway authorities admit that the new arrangement yields a substantial increase of accommodation, as compared with the type of corridor car now in use, with the corridor at one side of the car and the compartments opening upon it. The old form admitted three on a seat; the new form allows four persons on two seats across the car.

THE PINTSCH LIGHTING SYSTEM is being rapidly extended, according to a late report of the Julius Pintsch Co., of Berlin, showing its adoption in 21 countries of the world for lighting cars and buoys. On Dec. 31, 1899, there were 98,182 cars throughout the world equipped with this light; 14,883 of these being in the United States, and 36,305 in Germany. The latter country also had 3,784 locomotives fitted with this light. Of works specially equipped for furnishing Pintsch gas, there were 305 on the date mentioned; and 1,038 buoys and beacons were so lighted. In the case of the latter, France, England, the United States and Egypt lead, in the order named.

THE CASCADE TUNNEL, on the Great Northern Railway, is nearing completion. It will be 13,252 ft. long, and cost about $3,000,000. This tunnel, 24 ft. high by 20 ft. wide, was commenced in January, 1897, and last November's progress record was 527 ft. of tunnel driven, says the Tacoma "News." The best week's work was 76 ft. The tunnel pierces the mountain 2,500 ft. below the crest, and its completion will do away with the old "switchback" and probably save 20 hours per day in the time of all the trains crossing the mountains.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision between two passenger trains on the Chicago & Northwestern R. R., at Des Moines, Iowa, on June 11. Both engines were demolished and one man was killed.

A HEAD-ON COLLISION between two electric cars on the Rhode Island Suburban R. R., at Providence, R. I., on June 10, resulted in the death of four people and the injury of 14 others. One of the cars ran by a waiting switch, contrary to orders, and met the incoming car on a sharp curve.

AMERICAN CONCESSIONS IN HONDURAS are noted by a correspondent. The government of Honduras has granted a concession to the American-Honduras Co. for building jetties at the mouth of the Patuca River, the largest river in Honduras; also for the construction of a 60-mile canal along the north coast, from Tocomacho to Caratasska Lagoon; also a railway from the head of navigation on the Patuca River to Juticalpa, a distance of 65 miles, including the improvement of the river for 150 miles. The surveys and plans have been made and accepted by the government, and land is also conceded for building a town at the mouth of the Patuca. The American-Honduras Co. has a grant of 247,110 acres of valuable banana, rubber and orange land, and its Chief Engineer is Capt. J. Francis Le Baron, M. Am. Soc. C. E.; the headquarters of the company are at Cleveland, O. A concession has also been granted to ex-President M. A. Soto for a railway from Tanjillo to Olanchito, 70 miles, and for the navigation of the Aguan River; this concession is in the interest of the U. S. Fruit Co., of Boston, Mass. Chambers & Co., of Philadelphia, have a concession for the navigation of the Chameleon and Ulua rivers, and a railway from the head of navigation on the Ulua to Concordia, in the Department of Olancho. This railway will be 70 miles long and surveys are in progress. The Interoceanic Ry. Co., Astor, Depew & Co., has secured a new contract for completing their road across the Isthmus, and expect to recommence work at once on the northern end.

THE CUNARD STEAMER "SAXONIA," lately built by John Brown & Co., of Clydebank, Glasgow, is described as follows by U. S. Consul F. D. Hill: Length between perpendiculars, 580 ft. and 600 ft. over all; beam, 64 ft. 4 ins.; depth to shelter-deck, 49 ft. 4 ins.; but there are three decks above this, and from the top of the wheel-house on the navigation deck to the water is 65 ft. at 29 ft. draft. The gross register of the "Saxonia" is 13,988 tons, and her cargo capacity is 800,000 cu. ft., or 20,000 tons measurement, and her weight fully loaded is 25,000 tons. The ship is driven by two sets of quadruple expansion engines of 11,400 I. HP., or 10,000 HP. under natural draft; under the latter she has a mean speed of 15.8 knots. As a troop-ship she can carry 200 officers, 3,500 men and 10,000 tons of stores; or she can carry 1,900 horses and 400 troops. As a regular liner, she has accommodations for 150 to 200 first-cabin, the same for second-cabin, and 1,700 to 2,000 third-class. The last have airy cabins, bunks in two tiers only, water and wash-basins, and excellent baths and lavatories. The food is served in saloons with fixed tables and cushioned seats, and the men have a smoking-room and the women a parlor with a piano. The "Saxonia" can store coal for 40 days, steaming at 15 knots.

THE NEW BROOKLYN DRY-DOCK, now under construction by the Morse Dry Dock Co., at First Ave., between 55th and 56th Sts., has a front along this territory of 426 ft. The dock is to have an extreme length of 700 ft., so that it can accommodate the "Oceanic" with its 704 ft. over all. The two piers enclosing the wet dock will extend out 1,400 ft., to the edge of the newly-dredged 40-ft. channel. The first 700 ft. of the basin is to be 37 ft. wide and 25 ft. deep, intended for vessels of moderate draft; the outer 700 ft. is to be 100 ft. wide, with 35 ft. of water. The south pier is 22 ft. wide, and the north 30 ft. wide; on the north side of the latter will be the dry-dock basin, with a clear width of 130 ft., depth of 35 ft. and a length of 1,000 ft. On the north of this basin will be another 30-ft. wide pier; and each pier is to be traversed by a railway leading to the repair and boiler shops. A large coal-pocket will be located about midway of the south pier. The boiler shop will be east of the dry-dock basin, with the repair shop adjoining; the combined length of these buildings will be 600 ft. by 80 ft. wide. The body of the pontoon dry-dock will be 120 ft. wide, with a maximum depth of 15½ ft. at center, built in seven sections, each 80 ft. long. The two side wings of each section are to be 56 ft. high, from the top platform to the bottom of the pontoon. On the floor of each wing there will be two centrifugal pumps, each pair driven by a 50-HP. electric motor, placed on the working platform above. These pumps have a capacity of nearly 6,000 gallons per minute, giving a lifting capacity of 2,500 tons to each pontoon, or 17,500 tons when acting together. It is estimated that a large ship can be lifted out of the water in from 30 to 45 minutes. Extensive use is to be made of compressed air in calking, riveting, chipping, etc., and mains for this power are laid down each pier.

THE WHITE STAR STEAMER "OCEANIC," leaving Liverpool on May 30, made the distance of 2,888 knots in 5 d. 21 m. 47 s., at an average speed of 20.37 knots. Her best day's run was 524 knots.

THE CHAMBLY WATER & POWER CO., 25 miles northwest of Stanbridge, Canada, is about to increase its power. At the present time the Chambly works develop 7,500 HP.; but by taking additional power at St. Therese rapids, 3 miles further up the river, they expect to add 10,000 HP. to that now available. The old works are also to be extended so as to yield 20,000 HP., and this work may be finished this summer. It will take 18 months to complete the work at St. Therese. No description is given of the new works, although electric power is intended.

THE CARNEGIE LIBRARY, at Pittsburg, Pa., may be moved bodily a distance of 1,000 ft. and over a ravine 100 ft. deep; that is, if the plans are carried out as made by Mr. E. M. Bigelow, Director of Public Works, of Pittsburg. This library was built by Mr. Carnegie at a cost of $800,000, and is a steel and stone structure, 332 ft. long by 148 ft wide and three stories high. It stands at the left of the main entrance to Schenley Park, and the improvements being made there would leave the library in a cramped and undesirable location. Mr. Bigelow now proposes to move it to a better site on the west of the park entrance. He would jack up the building, put car-trucks under it and lay rails to the new site; the ravine to be crossed is 200 ft. wide, and this would either be filled up or falseworks would be used. The estimated weight of the building is about 58,000 tons. The plan is under consideration, and Mr. Carnegie proposes "to pay the freight."

A SUIT TO PREVENT A CITY FROM POLLUTING its own water supply has been brought by the Oshkosh Water-Works Co. against the city of Oshkosh, Wis. The supply is taken from Lake Winnebago. It is claimed that since the water-works plant was built the city has built sewers discharging into the lake near the pumping station of the water company.

THE ABOLITION OF THE GARBAGE REDUCTION Works on Barren Island, at which the bulk of the garbage of Greater New York is treated, has gone into the courts. The last legislature of the State of New York passed an act (Chap. 663, laws of 1900) designed to close up this establishment immediately, unless the board of health should extend the time, but the extension could not be to a later date than May, 1901. The New York Sanitary Utilization Co. has brought action in the New York Supreme Court to prevent the board of health from ordering the works closed. The plant was described at length in our issue of Feb. 1, 1900, and the proposals to order it closed were discussed editorially in the same issue and in our issue for March 29.

STEEL FOOTBRIDGE OVER THE RIVER SPREE, NEAR BERLIN, GERMANY.

We illustrate in the accompanying cuts a general view and some of the more interesting structural details of a steel footbridge which has recently been completed to give the Niederschoenweide station of the Berlin, Germany, city railway direct connection with the factory district of Oberschoenweide, on the opposite bank of the river Spree. At the point where the bridge crosses it, the Spree makes a sharp bend which is quite troublesome to navigation, and in designing the bridge it was important that these difficulties should not be increased by the structure itself. As the bridge was finally designed, therefore, it consisted of three spans—a center span of 86 m. (282.08 ft.), and two shore spans, each 43 m. (142.04 ft.) long—supported by inshore abutments and two piers near the edges of the main river channel. At the center of the main span the clear height of the bridge above water is 9.7 m. (31.8 ft.), and this height gradually decreases to 8 m. (26.24 ft.) at the piers, and to 4.1 m. (13.45 ft.) at the ends of the shore spans.

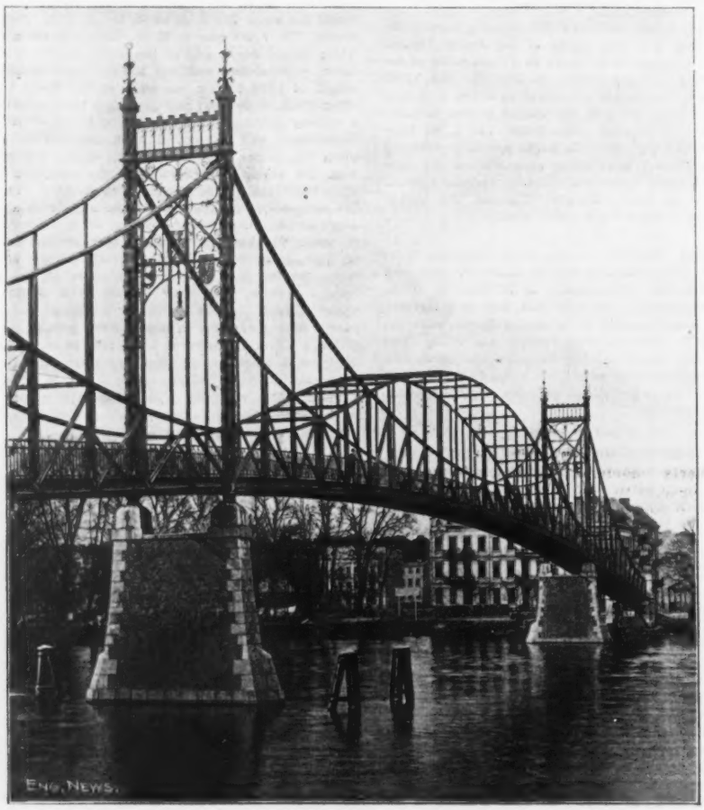


FIG. 2.—PERSPECTIVE VIEW OF FOOTBRIDGE OVER THE RIVER SPREE, NEAR BERLIN, GERMANY.

The most interesting general feature of the bridge is its composite construction. As will be seen from the diagram elevation, Fig. 1, and also from the perspective view, Fig. 2, the steel superstructure of the bridge consists of two parallel cantilever trusses, into each of which is introduced a sort of intermediate chord member having the form of a vertical double reverse curve. This intermediate member was introduced in order to stiffen the main trusses against flexure, and to reduce the weight by relieving the cantilever trusses from long diagonal web members in the panels near the piers. The two cantilever trusses have a flexible or elastic connection at the transverse axis of the bridge, and the whole framework rests upon roller bearings on the piers, and has hinged or articulated supports upon the abutments. The lower chords of the cantilever trusses are straight between the abutments and piers, with an ascending grade of 1 on 12 toward the piers, and have the curve of a parabola with a rise of 1.6 m. (5.248 ft.) throughout the center span. The upper chord members take the form of a catinary curve. The trusses are spaced 3.8 m. (12.464 ft.) apart c. to c., and are divided into 48 panels each 3.583 m. (11.65 ft.) long. The arrangement of the web members is best understood from Fig. 1. The composition of the truss members calls for no particular mention. All web and chord connections are riveted.

The details which are of particular interest are the flexible connection of the trusses at the center of the main span, the roller bearings at the piers, and the hinged supports on the abutments. Fig. 3 shows the construction of the roller bearing on the piers. It will be noted that the bearing is hinged at this point, as well as having rollers for longitudinal movement. The hinged bearing at the abutments is quite clearly shown by Fig. 4. Fig. 5 shows the details of the flexible connection between the arms of the opposite cantilevers at the center of the main span. The purpose of these special connections and the manner in which they operate are obvious from a study of the drawings.

FIG. 1.—DIAGRAM SIDE ELEVATION OF FOOTBRIDGE OVER THE RIVER SPREE, NEAR BERLIN, GERMANY.

The erection of the spans was accomplished without fixed falseworks, except for a temporary pier of piles at the center of the river span. The steelwork was erected complete on shore in four sections, namely, the two shore spans and the two arms of the center span, except for the curved intermediate chord in the center span. Each section was run onto a falsework carried on two barges fastened together, floated into position, and lowered onto the supports, after which it was connected to the adjacent sections. The intermediate curved chord in the center span was erected after the two cantilever arms were in place. The time required to load a section onto the barges, float it into place, and lower it upon the supports was one day. After the river span had been connected up the temporary pile center pier was removed, leaving the entire width between piers free for navigation. The piers and abutments were of brick masonry, with a granite facing on the up- and down-stream ends, and a granite base. The total cost of the bridge complete was 115,000 francs, or about $27,600. The contractor for the superstructure was Mr. Aug. Kloenne, of Dortmund, Germany. We are indebted to "Le Genie Civil" and "Zeitschrift fur Bauwesen" for the information from which this description has been prepared.

TRACKLAYING BY MACHINERY ON THE CANADIAN PACIFIC RY.

The tracklaying on the Columbia & Western line of the Canadian Pacific Ry. (Crow's Nest Pass extension, Eng. News, March 10, 1898) was carried out during the summer of 1899. The work was done by means of a steam tracklaying machine, under the direction of Mr. A. C. Dennis, Division Engineer of Construction, C. P. Ry., to whom we are indebted for particulars of the organization and execution of the work. The tracklaying machine, supplied by the Roberts Steam Tracklaying Co., of Seattle, Wash., consists of a head or "pioneer" car fitted with side chutes for delivering the rails and ties on the ground ahead of the train, and having a stationary steam engine to operate the rollers in the chutes. Similar chutes or tramways extend along each side of the flat cars of the material train, these chutes being carried by brackets inserted from the bottom of the stake pockets. Ordinary flat cars are used. The chutes are connected between the cars, and in the bottom of each chute are live rollers, the alternate rollers being driven by a shaft extending the whole length of the train and being fitted with universal couplings between the cars. The vertical engine on the head or pioneer car drives the shafts by means of gearing, and takes its steam from the locomotive. The rails are sent forward on one side of the train and the ties on the other, the ties being delivered by the chute about 60 ft. ahead of the rails, while the rail chute extends about 6 ft. beyond the car. The driven rollers of the tie chute have corrugated surfaces, to get a good hold on the ties, while the alternate rollers are plain, and are set about 1 in. lower than the others. The material train is made up with the rail cars in front of the locomotive and the tie cars behind.

At the material yard eight men and a foreman were employed in unloading, sorting and reloading rails and fastenings, and in curving rails. Each car sent to the front with rails was numbered with a consecutive or lot number, and also marked with the initial station of any curved rails it carried, the first and last rail of each curve having the station painted on it. The cars of rails loaded for the front were trimmed with angle bars only. Spikes, bolts, tie-plates, etc., were loaded together in a separate car, which was used as a tool car, as noted later.

The tracklaying train was made up for half a day's work as follows: (1) The pioneer car; (2) four cars of rails carrying 1,000 ft. of track and anglebars, or about 22 tons; (3) the engine; (4) eight cars of ties carrying 250 to 270 ties each; (5) the tool car. A pushing engine was used at the rear when required. The anglebars and some bolts were transferred to the front end of the pioneer car, which carried a sort of apron provided for that purpose. The tracklaying force

project was distributed as follows: (1) The tie-line stretcher, whose duty it was to keep the tie-line stretched 4 ft. from track center stakes as a guide by which to line up the ends of the ties; (2) eight or ten "tie buckers," who took the ties from the end of the tie tram or chute (which extended about 60 ft. beyond the pioneer) and dropped them approximately at the required spacing; (3) the tie marker, who marked ties where rails should lie across them, and kept the

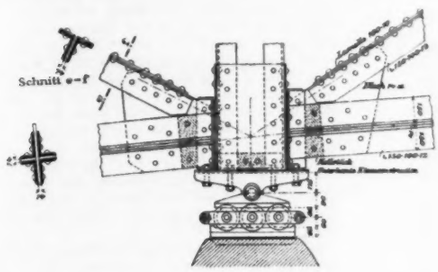


Fig. 3.—Detail of Roller Bearing at Piers; River Spree Footbridge.

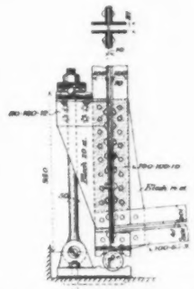


Fig. 4.—Combined Hinged Anchor and Roller Bearing at Abutments; River Spree Footbridge.

spacing "pole" moved up as required; this pole was a piece of band iron 30 ft. long, with a ring in the front end to pull it along and having copper rivets at intervals to mark the proper spacing of the ties; it was placed just outside of the tie line. (4) two men with "picaroons" lining the ties to the tie line, and at the same time squaring and spacing them according to the rivets in the "pole." All this work was entirely ahead of the steel or rail gang and out of their way.

The steel gang consists of eight "heelers" and two "strappers." The strapper puts a pair of angle bars on the last rail laid, and one bolt, not yet tightened. When the next rail came he opened the angle bar with his wrench to receive the rail end. The rail was "entered," the front end dropped and rail pushed back against the expansion shim, the bolt tightened up, and bolt struck and nut started for rail just laid. This is called the "slow heel" method, but is believed to be just as quick as and to give a better chance to regulate the expansion than the common method of throwing each rail back against the one laid. By the time the first bolt is tight the conductor signaled the engineman to move ahead, and the train advances a rail length. No spiking at all was done ahead of the train. The rails were held to gage by bridle bars, two to a rail length on tangents and three on sharp curves. These bridles were ⅝-in. rods, flattened at the ends and turned back so that the rails were at proper gage when the bridle was hooked under the base of the rails. There was a slot through it at the inside edge of the rail, through which a spike was stuck. The bridle was hooked under the line rail, a spike dropped in the slot, and the gage rail thrown in so as to clear the turned over part of the bridle; the bridle being held up and the rail pushed out it hooked itself, and on the spike being dropped in it was secured. The bridles were put on by the "heelers," who generally got them on before the "strappers" could fix their joint.

On the "pioneer car" there was the engineman for the stationary engine that ran the tram rollers, and one of the train crew to give signals to the locomotive engineman by means of whistle signals from the stationary engine. There were three men on the tie cars throwing ties into the trams or chutes with "picaroons;" one man on the tool car dropping off bolts and tie-plates, and two spike peddlers distributing spikes for each tie. The back gang consisted of two men lining, spacing and squaring any misplaced ties, taking off the bridles, and putting the tie-plates under the rails; one man picking up bridles and sending them to the front in a long narrow box over the tie trams; four or six gangs of spikers (each consisting of two spikers and a nipper), and finally two back bolters. This force would lay a pair of rails per minute, or sometimes a little better. It averaged 1,000 ft. of track per hour, and always had to lay the four cars of steel, besides putting up and taking down the tramways or chutes before stopping for dinner. They would do the same in the afternoon. The night crew did the switching at noon, making up the material train for the afternoon, and at night brought up the loads required for the next day. Ordinarily camp cars and stock of material were within 10 miles of the front. Ample motive power was necessary, as the train must be able to start quickly at each move. Two medium consolidated locomotives proved rather slow for handling the 14 loads on a grade of 22%. No cars without air brakes should be loaded for the front.

The Roberts "machine," by which is meant the train equipped with the appliances already mentioned, would work on curves of 14°, but not on a temporary curve of 22° on which it was tried. Mr. Dennis considers that the new Roberts "tie distributer" will work when it is made stronger, and then by having two gangs of heelers the machine will lay twice the amount of track, and the train need never come to a full stop. It is possible with iron cars or rail cars to put on enough men to lay more tracks by hand than with the machine, but this is more expensive, and it is very difficult to regulate the expansion, as one strapper will steal from the next one, and the rails are dropped so carelessly for long stretches that bolts can hardly be got in. The gaging and spiking are also done hurriedly to let the train come up, and under this system, generally speaking, the track is "dropped down" rather than "laid."

The Holman tracklaying machine is still used to some extent by the Canadian Pacific Ry.

In this connection it is of interest to note that in the construction of 120 miles of the Washington County R. R. (Maine) last summer, the Holman tracklaying machine was used by the contractors, the Eastern & Southern Construction Co., of New York. The operation is very similar to that of the Roberts machine, except that the rollers are not driven by steam, the rails and ties being simply pushed down the roller tramways. Mr. John B. Carter, of the construction company, states that the largest amount of track laid in any one day was 10,300 ft., fully tied and spiked; this was laid in 9 hours with 110 men. Two train loads of material were usually laid each day, the trains consisting of about three cars of ties and three cars of rails. The first train was taken out in the morning, and it was usually arranged to have the second train at the nearest siding at noon, when the trains were exchanged. The ties were distributed about two rail lengths ahead of the rails, and the full number was always laid, as it was considered that with machine work it was cheaper to do this than to put in only half the ties in front and to lay the rest behind the machine.

There were usually about 90 men in the gang, distributed as follows: 26 running ties out; 3 running rails out; 8 receiving and placing rails at the front; 6 carrying ties to the front; 2 lining; 2 bolting up splice bars; 30 spiking; 4 lining and spacing ties, and 6 helping, waiting on the others, etc.

A SYSTEM OF SIGNALING FOR RAILWAYS.*

By W. S. Boult, Assoc. M. Inst. C. E.

The object of this paper is not to classify and compare the work that has been done in various directions in regard to railway signaling, but rather to deal with the question de novo in connection with successful practical work with apparatus described below. It is surely a reflection on the present age, which justly prides itself on the advanced state of scientific knowledge and its application to practical purposes, that in a thick fog the only means of informing a driver of an approaching train that his next signal is against him should be to send out a man to put on the line something that will make a noise when the engine goes over it, and that, if no noise is heard, the driver is to assume that the line is clear, and he may go on—a method of working considered too dangerous to employ in regard to clear weather signals. Independently of other objections, there is often great difficulty experienced in regard to having the men at their posts when wanted, notwithstanding all that has been done by the railway companies in preparation for emergencies, including the building of large numbers of cottages for the men, and the fitting up of electric call bells. It is not a very long time since an accident occurred directly after the foggers had been withdrawn, owing to a small unnoticed bank of fog and a train arriving together at a signal standing at danger, which, being invisible to the driver, was run past. In the case of fogs of exceptional duration another difficulty comes in owing to the men all being worn out with long hours and exposure to the weather. Fogging also is dangerous work

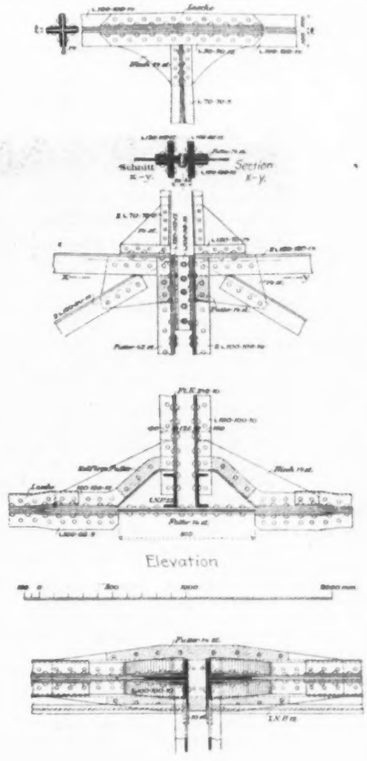


Fig. 5.—Details of Flexible Connection at Center of Main Span; River Spree Footbridge.

for the men so employed, and has been the cause of numerous injuries and fatalities. Mr. W. M. Acworth, in "The Railways of England," says: "A long-continued fog seldom lifts without leaving one or two gaps in the army of platelayers."

Let us now more carefully consider the requirements for any system of fog-signaling and what they entail.

1. Certainty of Action.—The necessity of as near an approach to absolute certainty as may be attained by fallible humanity and apparatus need not be contended for. The best way of obtaining this result is, first, by the utmost possible simplification and protection of apparatus—especially moving parts—and, second, by independent duplication of fundamental parts, as practised now in the case of detonators.

2. Simple Construction.—As just pointed out, this conduces to reliability; it also has an important bearing on first cost and maintenance expenses. It is evident that

*Abstract of a paper read before Section B of the British Association for the Advancement of Science.

complicated or delicate apparatus would be quite out of place for constant work on a locomotive.

3. Slow Deterioration.—This is important as affecting both reliability and cost of maintenance. It is absolutely necessary that there shall be no chance of anything working out of adjustment, bending, breaking, wearing away, or otherwise giving out, without ample notice through infrequent periodical examination.

4. Good Protection from Accidental Damage.—All parts of apparatus should be securely boxed in, or so strong as not to be liable to injury by accidental knocks from falling objects, etc.

5. Easy Replacement of Damaged or Worn-out Parts.—This obviously is most important, not only as affecting the cost of repairs, but preventing the possibility of causing delays to traffic.

6. Minimum Amount of Cleaning and Overhauling.—In view of the large amount of apparatus that would be required, this is of great importance, as seriously affecting maintenance expenses. To this end it is most desirable that all moving parts, whatever that would be, in any way liable to clogging or injury by dirt or weather should be completely boxed in.

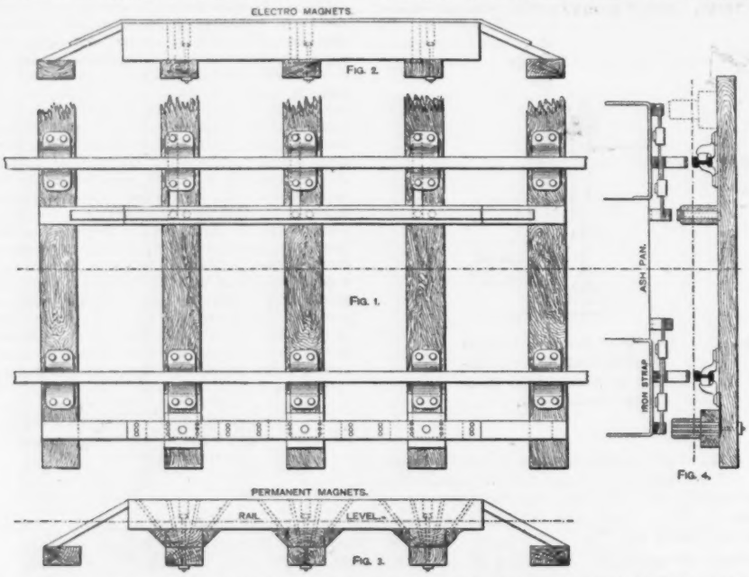
7. Moderate First Cost.—This is chiefly important in view of the number of apparatus required. It is, however, not of such consequence as

8. Moderate Maintenance and Working Expenses.—Seeing that thick fogs occur only on a few days out of the 365, it is evident that to be successful fog signal apparatus must require very little attention to keep it in operative condition.

9. Signals must be given in the Cab of the Engine and in any Vehicle fitted with Receiving Apparatus.—The object of signals being to convey information to the engine driver, it certainly seems that the natural and best place in which to exhibit visible signals is right in front of the driver's face; audible signals also are to be received in the cab of the engine, and naturally should be given there. The best form of signal is a point requiring discussion; probably at all events for danger signals, a miniature semaphore or equivalent signal and continuous-action electric bell form the best combination, the bell continuing to ring so long as the signal remains on, or until the driver's attention is attracted. Many locomotive engineers do not view with favor the idea of applying to their engines apparatus which they deem to be dangerously fragile and liable to damage. It is for the designers of such apparatus to treat with all respect views founded on practical experience of locomotive working such as the majority of such designers do not possess, and to spare no pains to render their apparatus simple, strong and well protected. There is another consideration often urged against giving signals on the locomotive, viz.:—that all locomotives using any line worked by such signals must be fitted with receiving apparatus.

This difficulty is purely one of agreement amongst the various railway companies, and should be capable of settlement whenever any one system has proved itself thoroughly fitted for its work, and superior to all competitors. When once this state has been reached, and a system universally adopted, it will be just as much a matter of course to fit an engine with receiving apparatus as it is now to apply a safety valve or brake apparatus. The unnecessary loss of money incurred in fitting up rolling stock to suit two or even three systems of continuous brakes, should be taken as a warning not again to deal piecemeal with a subject better made a clearing house matter.

10. Action must be independent of Speed, or even Movement of Engine, and applicable as a Starting Signal.—This is clearly necessary, as not only may a signal have to be given to an engine traveling at any speed, but it should be possible by the same system to start an engine that has been stopped.



FIGS. 1 TO 4.—PLAN AND SECTIONS OF RAILWAY TRACK WITH PERMANENT MAGNETS AND ELECTRO-MAGNETS IN PLACE FOR FOG SIGNALLING.

Fig. 1.—Plan showing Groups of Permanent and Electro-magnets on the Road. Fig. 2.—Electro-magnets in Side Elevation. Fig. 3.—Permanent Magnets in Side Elevation. Fig. 4.—Cross-section showing also Four Armatures carried by Iron Straps attached to the Ash-pan and Frame of the Engine.

11. Apparatus must Work when Engine is Run either end First.—Tank engines at least must be able to take signals when running either end first, and all engines must be able to pass up or down a line without doing damage. If any special movement has to be made to compensate for reversed running, this can probably be done by an attachment to the reversing lever.

12. Two distinctive Signals must be given—for "Danger" and "Line Clear," respectively.—This, of course, would be a great improvement upon the present method of giving danger signals only, and greatly help the driver in determining this position, besides doing away with the necessity for treating no-signal as line-clear.

13. Distant and Home Signals must be clearly Differentiated.—Here, again, the driver will be assisted in determining his position.

14. The Signals must be capable of Re-delivery at Intervals, as arranged.—By this means the driver may be as well informed as by seeing a semaphore from a distance. Requirements 12, 13 and 14 together ensure as great facility in signaling in fogs as is obtained by semaphores in clear weather.

15. Repeating in Signal-box must be Provided for.—It is obviously necessary that the signalman shall know definitely that he has set his apparatus as intended.

16. A clearing Signal should be given from the tail Vehicle to the Signal-box to show that the whole Train has Passed, and on which Line, if more than one each Way.—This signal is especially wanted in thick fogs, when the tail lights of a train are visible only within a very short range, and it may not be easy for the signalman to see on which line a train is running.

17. Commencing Failure of Action must be at once Indicated while Correct Signals are being Given.—The best method of meeting this requirement is probably by independent duplication of fundamental parts and separate indication of their action. It may also be met by complete duplication of receiving apparatus. In either case the chance of two failures at the same instant is so remote as to be negligible.

18. It must be impossible for an Engine-driver to mistake another Signal for his own.—Any signal given in the cab of the engine prevents all possibility of a signal meant for one engine being acted on by another. This is another argument in favor of signaling on the engine, as emphasized by the collision at Crewe on October 4th, 1897, when four goods trains were wrecked in consequence of an engine driver acting on another man's signal.

19. Failure of Apparatus on the Road must give the Danger Signal on the Engine.—This is insisted on in the case of semaphores, which are weighted so as to [illegible] the danger position if a connection breaks; and sur[illegible] it is doubly needful in foggy weather, though not [illegible]ined with the present system.

20. It must be impossible for the Engine-driver [illegible] Tardiness in Stopping a Bell, working a Signal Rep[illegible], or otherwise, to Prevent the Receipt of a succeeding [illegible]gnal. —Interference with a following signal by late repe[illegible]ment may be guarded against in different ways; but, [illegible] least in the case of danger signals, it is clear that it [illegible]t be absolutely guarded against.

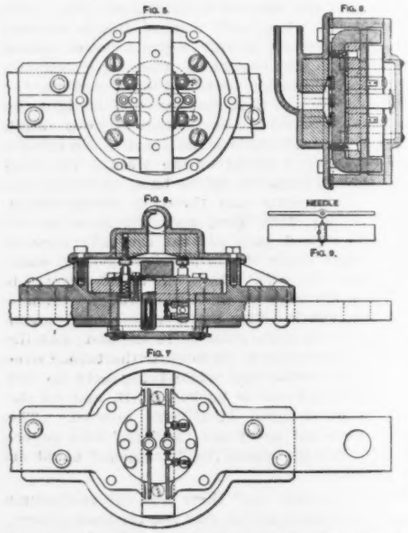
21. The whole Apparatus must be unaffected [illegible] Fog, Frost, Snow, Rain, Hail, Wind, or Changes of T[illegible]perature.—It is, of course, a sine qua non that the ap[illegible]atus shall work equally well, and without special adj[illegible]ment, at all possible temperatures and in all weathers.

22. Means must be provided for Indicating w[illegible] of Several Branch Raods is Made.—It is highly d[illegible]able that the engine-driver should know that he is a[illegible] to be sent on to the line he wants; but as the worst result of a mistake would be loss of time, this is essenti[illegible] only from a business point of view. Without such infor[illegible]ation it would be necessary, wherever there was a poss[illegible]ility of being turned on to the wrong road, not to go faster than would be safe on the worst road that could be given.

23. Each Signalman should be able to Veto "Line Clear" given by the Signalman in advance.—This is the quickest way of stopping a train in which anything wrong was noticed as it passed.

24. The system must admit of "Lock and Block" and Automatic Block Working.—The advantages of "lock and block" working are now generally admitted. For "light railways" and other purposes it is probable that automatic block working might be advantageously adopted.

Apparatus actuated by mechanical contact between something on the road and something on the moving engine could, it is at once evident, never be satisfactory or inspire confidence, however often it worked all right; for blows given at a speed of 120 ft. per second—the actual speed occasionally attained by some express trains—could not fail to quickly find out and develop any incipient flaws, however well proportioned, balanced and alined the apparatus might be. Moreover, wear of rails, ties and contact pieces would necessitate perpetual overhauling and adjusting on both road and engines. Further, it is much to be desired that there should be no movement into and out of contact position of anything on the road, as all such moveable parts would involve the expense of constant cleaning, oiling and overhauling, even if required in actual use on only a small number of days in the whole year. Their action also must depend upon the proper compensation or adjustment of the already overloaded distant signal wire



Figs. 5 to 9.—Armature Relay of Fog Signalling Apparatus.

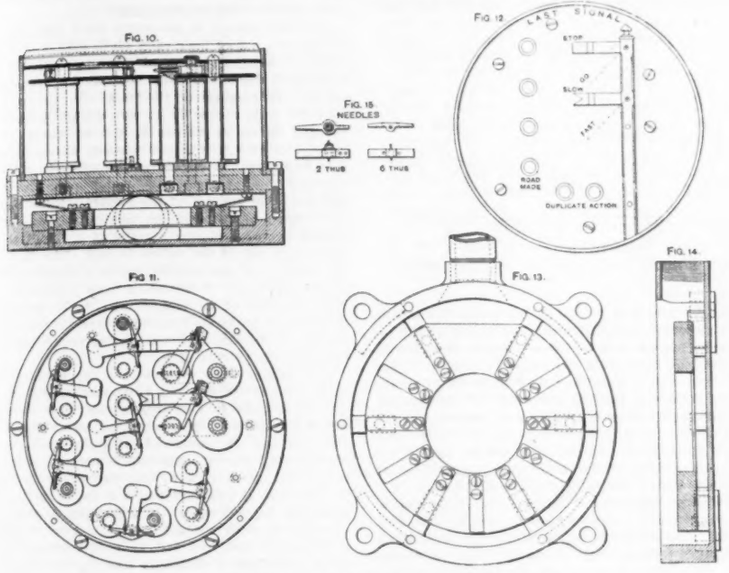
just at the time when the semaphore is invisible, so that all such moving parts would have to be repeated in the signal box. These objections apply more or less to all apparatus for placing detonators on the rails, many forms of which have been proposed, though at best only a danger signal is thus given, and the magazines have to be looked after and kept supplied with detonators which are used up at all sorts of varying rates—always supposing the machine remains in working order.

Another plan, adopted by numerous inventors, is the employment of electricity as the medium of communication with the engine, and at first sight this seems to offer great advantages. On consideration, however, many objections appear. Bare, insulated, and necessarily unprotected, conductors, must be laid on the road, and

contact made therewith by a brush or contact piece on the engine. This, of course, may be in the form of a wire brush, or a plate spring, or be otherwise made more or less elastic, so as to reduce shocks, but, for all that, at some speeds, shocks there must be, as well as wear and tear, the latter always tending towards want of alinement. It is clear that, sooner or later, missed contacts between the moving brushes and roadway conductors would be liable to occur, even if nothing got carried away. Dirt, snow and frost, would also be likely to prevent metallic contact. Again, with bare contact bars, the current might in various accidental ways be short circuited or weakened. But the fatal objection to purely electrical systems is, that failure of current in the roadway conductors or of contact therewith results simply in giving no signal, which, of course, might easily lead to most serious disaster. The author is aware that it has been proposed to guard against this contingency by causing the brush-holder, when the brush is raised by contact with the roadway conductor, to act as a switch to close a local circuit through a battery on the engine so as to show a fault signal if this is not held off by the main current.

This, however, involves the use of two systems—electric contact and mechanical movement—and necessarily increases shocks, wear, and liability to damage; and, if failure of the main circuit is due to the brush having been carried away, or to its clearing the contact bar owing to bending or wear, is no safeguard whatever, as the cause of failure affects both circuits alike.

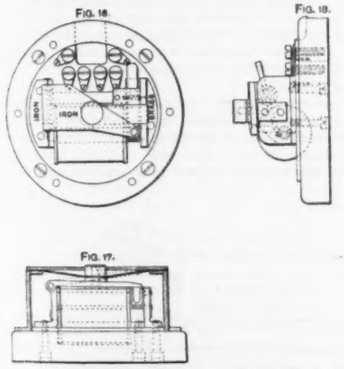
Sight, hearing, mechanical movement, and electric contacts, judged by the standard of requirements given, all fail to do all that is wanted. Appealing to the sense of smell also is, for obvious reasons, out of the question. There remains one means of transmission not yet mentioned, that is, magnetism, and consideration shows that magnetism is thoroughly well suited to the purpose in view. There are three ways in which magnetism can be employed to work across an air gap, such as is desired between the stationary and traveling parts, viz.:—(1) By direct pull on the traveling armature, mechanically transmitted thereby; (2) by inducing a current in a conductor on the moving vehicle; and (3) by actuating a pivoted needle or spring tongue, which may be incorporated with a rigidly held armature on the vehicle to be signaled. The first two methods have previously been proposed, but clearly cannot do all that is wanted. No. 1 would need impossibly large magnets (at all events, except where dynamo currents were available), would actuate mechanism with great suddenness, and would give only one signal for each armature and set of magnets, and No. 2 would simply not work on a standing or slowly moving vehicle, and, at best, like No. 1, would give only one signal. The third method, however, which appears never before to have been suggested, possesses none of thes drawbacks.



FIGS. 10 TO 15.—INDICATOR IN ENGINE CAB.

Arriving at this conclusion in the manner above set forth the author turned his attention to devising suitable magnetic apparatus, with results which he now has the honor to submit for criticism. In brief outline his system consists in placing on the road magnets so arranged as to establish a long magnetic field of transverse polarity, and carrying on the engine through this field an iron armature, not itself to be moved by attraction to the magnets, but containing in a dividing gap or space therein a small pivoted needle on which magnetism collected by the armature is condensed or focussed so as to strongly act upon it and throw it over to one side. The polarity of the field from the road magnets is arranged to be from right to left, or left to right as required; and, as the direction in which the needle in the moving armature is thrown over depends upon the polarity of the magnetism collected by the armature, it is evident that the combination forms a simple means of determining the movement of the needle. The needle when thrown in one direction comes against an insulated contact post and thus closes one electric circuit on the engine, and when thrown in the opposite direction, similarly closes another circuit. When away from the influence of road magnets, it is magnetically, or otherwise, held in the middle of its travel, and clear of both contact posts. The action is that of the well-known polarized relay, the road-magnets and armature taking the place of the electro-magnets in the instrument used in telegraphy.

With the means of closing either of two independent local circuits (on the engine) thus provided, practically any signals preferred can be given and if desired recorded. After the usual experiments, consideration, and alterations incidental to the designing of new machines, the author's apparatus has now assumed the form shown in the drawings herewith.



Figs. 16 to 18.—Details of "Relay-Push."

Road Magnets.

The road magnets are by preference placed as shown in Figs. 1 to 4. Permanent magnets, arranged in fan-shaped groups on iron plates over the sleeper ends, are placed in holes bored through a longitudinal timber, as shown in Figs. 1, 3 and 4. The iron plates pass under the contiguous chairs, thus completing an iron connection to the upper surface of the rail, close to which travels a collecting pole plate on the engine armature. A similar pole on the other side of the armature passes just above the upper ends of the magnets. As will be seen from Fig. 4, with the exception of the desired clearance between stationary and traveling parts, a complete iron circuit is provided for the magnetic flux.

On the inside of the other rail are shown three electro-magnets very similarly arranged, but with their upper ends connected to a common pole plate. In practice the permanent and electro-magnets would not be on the same sleepers, but, as explained below, it is proposed to have the permanent magnets in duplicate—one set to each rail.

Armature Relay.

The construction of the armature relay is shown in Figs. 5 to 9. The ends of the old structure or bridge-piece shown are attached to the longitudinal pole plates above referred to, as shown in Fig. 4. Both the iron needles, 3 ins. long (see Fig 7, a view of the under side, with cover removed), are both polarized and controlled (or held in the central position) by a single horseshoe magnet, which, as its ends do not reach quite so low as the bottom edge of the needles (see Fig. 8), to a large extent relieves the pivots of their weight. It will be noticed that the control of the needles is due to repulsion from the horns of the iron bridge bars near their ends, which are similarly polarized by the magnet. This repulsion control allows a far wider play of the needles than an attraction control does, while at the same time simplifying construction. The needles may be thrown into absolute contact with the horns and not stick. There are four contact posts, against each of which a needle, when thrown over by road magnets, makes duplicate contact, so that for each signal there are four contacts, any one of which suffices for working. Connections with the circuit wire are made at the back, or upper side, of the ebonite slab on which the movement is mounted by means of plungers, such as are used in lamp-holders and insulated screws in the cover. Everything is inclosed in a jointed brass box.

Indicator.

Figs. 10 to 15 are views showing the construction of the indicator for complete signaling. The various indications are all given in the same way by a movement which may be explained in relation to the home semaphore. This semaphore is carried by a tongue or armature, pivoted on a magnet and playing between the cores of two coils, after the manner of a polarized relay, the cores and magnet all standing on a common iron base. The magnetic action, however, is not that of the telegraph relay, only one coil being energized to produce movement. For instance, if the semaphore, which is shown on, is to be thrown off, the right-hand coil will be energized with N polarity at its outer end (the outer end of the magnet and tongue being S), the effect being to strengthen the magnet, and, therefore, the tongue, and to reverse the polarity of the left-hand core, which then repels the tongue at the same time that the right-hand core is attracting it. Owing to the facts that the left-hand core is not too strongly magnetized, and that the magnetism of the tongue is simultaneously strengthened, seizing is prevented, and the tongue may be thrown through a large angle. Fig. 12 shows the dial of the indicator, with home and distant semaphores, duplicate action spots and four number holes for indicating the road made at junctions. Figs. 10, 13 and 14 show the permanently wired base of the instrument, with radiating contact springs for connecting up the indicator coils.

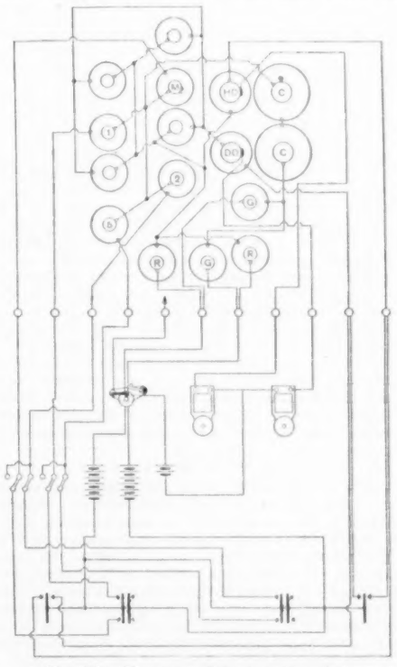


Fig. 19.—Diagram of Engine Circuits.

Relay Push.

Figs. 16 to 18 show an apparatus for breaking a bell circuit at a relay or switch closed by the signaling cur-

rent, and doing this in such a manner that the signaling current has always controlling power over the manual movement. For want of a better name it is referred to as a "relay push." It is constructed on a similar plan to the indicator movement above described, but has only one core and bobbin (with two independent coils in connection, respectively, with two separate batteries), a hinged flat iron bar taking the place of the second core. The polarized tongue acts as a switch in the bell circuit, being closed by signaling current passing through either or both of the coils on the bobbin. To open the relay and thus stop the bells the hinged iron arm is pressed down against the action of a spring till on iron stud on its end touches the tongue (which is not in contact with the iron

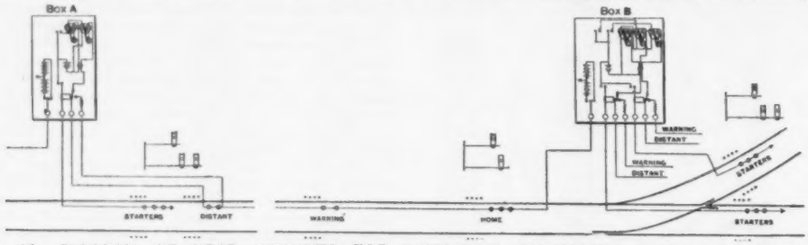


FIG. 20.—DIAGRAM OF ROAD CIRCUITS FOR COMPLETE SIGNALLING WITH "ECONOMY SWITCHING."

of the core). It is then allowed to spring up, dragging the tongue with it. At any instant throughout or after this operation signaling current will re-make the contact.

Engine Circuits.

The working of the whole apparatus will be best understood by a reference to Fig. 19, which is a diagram showing the connection of all the parts on the engine. The upper half of the figure shows the indicator coils connected with their terminals—a row of small circles extending across the diagram. At the bottom of the diagram are shown four armature relays carried underneath the engine, as shown in Fig. 4. The two outside ones have single needles only, and work in duplicate to give the danger signals. The circuits from these needles will be right whichever end first the engine is running. The other two armatures have duplicate needles, and give the "line clear" signal (both semaphores off) in conjunction with one road number. These circuits require reverse connecting for reverse running, switches for this purpose (which may be worked by the reversing lever of the engine) being indicated.

There are two batteries, with their positive poles connected through the two coils of the "relay push" to the two "duplicate action" or spot movements, and their negative poles connected to the armature needles, so that for each signal one needle in connection with each battery is operated. Failure of one needle contact, one battery, or one connecting wire, is immediately shown by the "duplicate" spots showing different colors and thereafter remaining fixed, a green spot showing for the defective circuit and a red spot for the working one. The running signals will still be properly operated by the remaining circuit. As this partal failure ought never to occur, it might be made a strict rule to run slowly in such a case.

Separate distant and home danger bells are shown, as well as the "relay push" for stopping them when the engine is standing, and doing this without interfering with the signal. The numbers M2, 1, 2, 5 indicate the respective coils for showing these numbers on the dial. HD and DD are the home and distant danger coils; CC, working together, give the clear signal; RR show red spots, and GG green ones.

Road Circuits.

Referring now to Fig. 20 (in which permanent magnets are shown by single and electro-magnets by double circles) it will be seen that at each signaling position the engine first gets the danger signal—distant or home, as the case may be, according to the polarity of the permanent magnets—immediately followed by "line clear" and a road number if current is on the electro-magnets. If current is not on, the danger signal only is taken. The diagram shows the arrangement at a junction, each branch from which leads to another junction. Equivalent roadside semaphores are also shown.

To economize, current may be switched on and off in the signal boxes A and B by means of the apparatus indicated, so that it is used in a section only whilst the train is there. In each signal box is a key, or plunger, for throwing nagnetic switches (constructed like the indicator movement above described, but not permanently polarized, and therefore workable by current in either direction) to close their respective circuits through contacts on pendant tongues and the cores of the lowest coils—taking the view as a front elevation. In each switch the tongue working between the two upper coils acts simply as a tumbler to move the pendent contact-making tongue through a small angle. On plunging, the tumblers will all be thrown into the position shown, and the respective circuits be all earthed. This will be done at each signal box on the approach of a train.

Suppose now that a line has to be cleared for an approaching train. The magnetic switches will be in the opposite position to that shown, with road circuits open. Signalman A switches in the battery for his starter magnets and B the battery to give the required polarity to the distant, warning, and home magnets. As the train comes near, A plunges (just before giving B the train-on-line signal), and thus completes the circuits through the magnetic switches, and current flows, the starter current immediately cutting in the distant magnets by the intermediate switch, as will be readily understood from the diagram. Current now flows through the two right-hand coils of each magnetic switch, whereby the pendent contact tongue is held hard up, and the tumbler is thrown over to the right, till held by its knuckle joint. As soon as the train has passed A, he breaks the starter circuit, so as to put this signal on. By means of the intermediate switch the distant signal is also immediately put on. Current ceasing in the right-hand coils of the left-hand magnetic switch, the pendent contact tongue is released, and pulled back by the weight of its tumbler. A similar action takes place in the other switch when B puts on the warning and home signals. In order that the right-hand magnetic switch may not be opened too soon, the intermediate switch may be constructed so as never to break one circuit till it has closed the other.

In the diagram small circles in the signal boxes represent galvanometers for showing when, which, and how much current is flowing in each circuit; that is in effect for "repeating." Crossed circles stand for "veto" switches, whereby a signalman, if he sees anything wrong with a train as it passes, can instantly veto line-clear signals given by the man in advance, without wasting time in communicating with him. For the number of branch lines shown, electro-magnets for one armature only are required. Where more than two diverging roads have to be signaled at the same spot, the other inside armature also must be utilized by another set of electro-magnets. It is then possible to select from eight different roads as follows:

Let the four numbers of the indicator controlled by the two armatures be respectively M2 and 1 on one armature and 2 and 5 on the other, then:

Branch No. 1 = 1.
" 2 = 2.
" 3 = 1 + 2.
" 4 = M2 + 2.
" 5 = 5.
" 6 = 1 + 5.
" 7 = M2 + 5.
Main Line = M2.

In any exceptional case requiring more than eight road indications, if such can be found, a second set of magnets to one of the armatures can be provided, giving two more, thus:

Branch No. 8 = 1 + 2 + 5.
" 9 = M2 + 2 + 5.

By doubling the magnets of the other armature as well, one more is obtainable, thus:

Branch No. 10 = 1 + M2 + 2 + 5.

A total of 11 roads can thus be differentiated if necessary—probably more than will ever be wanted under any circumstances.

With the indicator above described (see Fig. 7), the home semaphone on is an invariable order to stop; when off it signifies "Go," the distant arm pointing to "slow" or "fast," according as it is on or off. It is only when moving out of a block section up to a starter that this interpretation of the distant arm does not strictly hold, as the starting signal will be off or "fast;" but as in this case the train cannot be going fast, the giving of permission to do so does no harm. With the arrangement of road magnets shown in the diagram, the working of traffic is as follows:

Suppose a train traveling from A to B and finding the signals on. On receipt of the distant signal speed will be slowed down in the usual way. The "warning" (which might be, perhaps, 200 yards in rear of [illegible] magnets will throw on the home semaphore and [illegible] will be brought to a stand. After stopping it will crawl up the home magnets or block station, and step over the electro-magnets of this group, which, as shown by the third magnet, may have an extra long pole-plate. The bells may now be stopped by the "relay push." As soon as the current is switched on to the road magnets the starting signal will be given by the throwing off of both semaphores and the appearance of a road number; the "relay push" being at the same time again closed, ready for the next danger signal.

A simple scheme of automatic block signaling is shown in Fig. 21. At or near each block station is a two-point magnetic switch, conveniently formed with the polarized movement above described, controlled by road armatures operated by magnets on the train.

As the train comes up to each switch it finds it in the position shown at station A, and by means of its front magnet throws it into the position shown at station B, thus breaking the circuit of the magnets behind it and earthing both the rear end of the magnet wire in front and the other contact of the armature being passed. The tail magnet of the train on coming up closes the needle on this contact, thereby completing a circuit through the right-hand coil of the switch in rear. The diagram shows the position of the switches when a train has completely passed station B. A following train coming up to A will earth the rear of the magnet wire A—B, but the forward end will not be earthed until the leading train has reached station C; the following train being meanwhile blocked at the platform in rear of B.

This scheme thus ensures that the whole of one train must have passed out of a block section before another is allowed to enter it, and uses current in each section only whilst a train is in it. Such a system as that outlined in Figs. 19 and 20, compared with the usual methods of semaphores, colored lights and detonators, possesses most substantial advantages as the regular every-day method of working. In the first place, it is one system for day, night and fog, instead of three systems, as now used.

Obviously, such a simplification is most desirable. Not only are the first cost and working expenses thereby reduced, but there is distinctly less chance of mistakes being made, and there is no chance of the system required in any particular moment not being got ready in time, there being no lamps to light and no foggers to call out. Then the signal is always given in the same spot, and only the signal for the one train, so that the drivers' attention is not distracted from his engine, and a general look-out ahead to peer out anxiously and constantly, often through fog, snow, hail, rain and wind, trying to see in what direction a continual succession of arms on top of posts are pointing, or what colored lights are visible at frequent intervals, and decide which arms or which lights (often out of a large number in view at the same time, when not all obscured by fog or snow) refer to his train.

Again, if the present distant and home signals are on separate posts, there is nothing at night to indicate to a driver which it is he is approaching, so that there is always the chance of his mistaking a home "danger" light for a distant "caution," and so running past when he should stop. With the author's apparatus this is impossible.

There can be no two opinions as to which system, with equal reliability of action, is the safer; and railway engineers and managers should gladly welcome a system giving signals on the trains where they are wanted, instead of on the roadside, where they are not wanted, if they

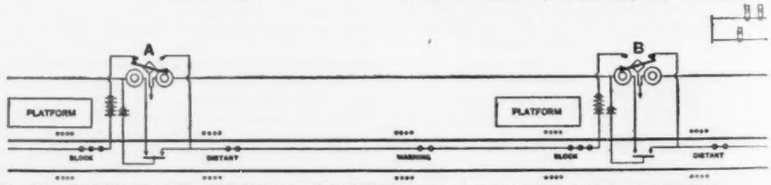


FIG. 21.—DIAGRAM OF ELECTRIC CIRCUITS FOR AUTOMATIC BLOCK SYSTEM.

only can have confidence in the certainty of its action under all circumstances. This raises the question of relative simplicity of construction, in which it will be noticed the advantage is all on the side of the author's system. The parts on the road are simply the boxed-in magnets and connecting wires, with no moving parts, as against a combination of signal wire and pulleys, post, ladder, lever, rod, semaphore, spectacles, lamp, "fogger" and detonator, an accident to almost any part of which will throw the apparatus out of order. Further, the magnets are completely encased, and so protected from accident, while the whole of the semaphore apparatus is thoroughly exposed to wind and weather and mechanical injury; indeed, the same may be said of the unfortunate foggers. The receiving apparatus carried by the train consists of parts, the management and keeping in order of which are well understood, and which are all carefully boxed in, so as to be protected from damage; besides being of so small and simple a nature as to admit of duplication.

In order to test the working of the armature relay and [illegible] movements four groups of electro and permanent [illegible] were put down on the up fast road of the Great [illegible] Railway at New Southgate, and an express en- [illegible] 1008) was fitted with two armatures, indicator [illegible]. Although the apparatus was in many respects [illegible] to the designs now put forward, signals were [illegible] perfectly at speeds of over 70 miles an hour, with [illegible] ce of over 3 ins. between armatures and road [illegible].

UNIFORM ACCOUNTING FOR GAS AND ELECTRIC LIGHTING COMPANIES.*

James Blake Cahoon.†

I doubt if there are in this association a dozen members who realize fully the gravity of the present situation for the private ownership of public utilities. The question is taking on a new form. Heretofore franchises have been granted haphazard, and little, if any, effort has been made by the different states to follow out any one line of policy with regard to either the granting of franchises or the regulation of companies under those franchises. Massachusetts has taken a step, and a long one, in the direction of regulation of all public utilities, and the compelling of all such corporations, be they private or municipal, to render to a board of commissioners an account in prescribed form at definite intervals.

There lie open before us the two paths: (1) Municipal ownership, or (2) private ownership under state regulation. We certainly do not want municipal ownership, therefore let us prepare to accede gracefully to the other course; and not only that, but let us help it along. To do that, we must be prepared, when the question of state regulation is raised, to meet the committee half-way; to say to them, Here is our system of accounting. It is one in which we believe the true costs to be stated; all the factors that enter into the cost are here. We are not a single company using this system; we are one of a great body, all of whom follow the same method and use the same system of accounts in determining their cost of production. We are perfectly willing to hand in once a year a complete statement of everything, costs as well as receipts, and show just what legitimate profit there is in this business. It is not great, and we are willing to have you know what it is and how it is computed. From a financial point of view, it matters little to this association what system of accounting its individual members may follow. If they are deceiving themselves in regard to costs, we as an association should not be warranted in interfering. We, at most, can only recommend the adoption of any system of accounting; we cannot compel our individual members to accept it, but we can at least ask them to do so.

The prime object of any system of accounting is that it shall be a true record of all the transactions relating to the business involved during the period of time in question. Without losing sight of this fact, the principal object of central-station bookkeeping is so to arrange these transactions under proper headings and groups as to enable us to ascertain: (1) The cost of our product delivered to the consumer; (2) the profit; (3) the distribution of the costs into different accounts in such manner that we may determine where economies should be made in order to bring that cost down to a minimum, while giving the maximum efficiency of service to our consumer. This ought to be so arranged that it shall, while satisfying all the demands of the accountant, give the greatest possible information to the manager.

The requirements of the Board of Railroad Commissioners for Street Railways in making up their annual reports seemed to me to be a good basis on which to work, and having with the aid of various experts—notably Frank H. Ford, of Ford, Bacon & Davis, New York city, and H. E. Babcock, auditor of Elmira Municipal Improvement Co.—first secured the outline of a form for making up a monthly report for the railway company of which I had charge at that time, I proceeded, step by step, to work out a method of accounting that would seem to meet these and the other requirements. There are five general headings or groups of accounts: (1) Construction; (2) Manufacturing; (3) Distribution; (4) General; (5) Capital. The first includes all construction charges connected with the building and equipping of a plant. The second, third, fourth and fifth accounts are operating-expense accounts. These accounts in turn are subdivided.

It has not been the custom heretofore to class capital accounts as, strictly speaking, operating-expense accounts, but in order that the true cost of the product may be ascertained, I hold that it is necessary to include these as part of the operating expenses, and not to classify them as deductions from income. At the annual meeting of the Street Railway Association, in 1898, the question of including taxes in the operating expenses was left open after a long discussion, as it had been the custom for years to consider taxes as not a part of the operating expenses, but as something extraneous thereto, which should be a deduction from income, as should also interest on investment, interest on current liabilities, investment insurance and reserve for sinking fund.

Why I take this stand, being open as it is to criticism, is for the following reason: We are not private companies in the strict sense of the word, we are operating public utilities; and the public is going to demand, and is demanding at the present time, to know what it costs us to deliver our product to the consumer, and what our profits are. Certainly, a part of our cost is taxes; and before we can declare a dividend, we must take care of the interest on our bonds, and also on our current liabilities. In regard to investment insurance, or depreciation, as it is often termed, this is truly a factor of cost. Every plant undergoes depreciation from year to year, and in order that the value of the plant may not be depreciated, certain renewals must be made, and minor extensions or betterments added.

If we do not charge off each year, and expend as an investment in renewals and minor extensions and betterments, a certain portion of the original investment, the time comes in the course of seven or ten years, when we have got to borrow thousands of dollars to renew the plant, and it may be at a time that will be very inopportune. The best policy for ourselves, laying aside the whole question as to whether or not it is better as a source of protection from the public, is to recognize this factor, and include it in our cost of operating expenses. A certain depreciation, determined on by experience, varying according to location and according to class of manufacture, we find will occur every year. Let us take, then, the yearly proportion on the basis of lasting so many years, and place it each year under the head of investment insurance, and use that in our business for minor extensions or betterments and renewals sufficient to keep our plant intact and in as good operating condition as when first purchased; or, in other words, maintain our plant in such a manner that if a question of being compelled to sell it comes up, we can show that we have maintained it in such a way that the original investment is not impaired in the slightest.

Again, as regards a reserve for sinking fund. Many have held to the idea that if they issue bonds for a term of 50 years, we will say, and pay the interest right along, that is all they can be asked to do; that when the time comes they can refund them, and therefore it is unnecessary to make any provision for a reserve sufficient to redeem the bonds at maturity. Others, again, say that by the time the bonds become due, our income will have increased so materially that we shall have no difficulty in taking care of them; they will be only a minor charge at that time; part of them can be redeemed and part renewed. Neither of these views is the true economic way of looking at the subject. The only true way is to recognize the fact that the bonds must be redeemed at maturity, and to make provision for their redemption by setting aside each year such a reserve as will take care of the bonds at their maturity, charging this reserve as part of the operating expenses, or, in other words, as one of the factors of the cost of production. We may thus see that the cost of our product is legitimately represented by the four groups: Manufacturing, distributing, general and capital.

*Abstract of a paper read at the annual meeting of the National Electric Light Association, at Chicago, May 23, 1900.

†Syracuse, N. Y.

DISTRIBUTING ILLUMINATING AND FUEL GAS UNDER HIGH PRESSURE.

In our issue of Oct. 5, 1899, we published an abstract of a paper by Mr. F. H. Shelton, of Philadelphia, in which he advocated the distribution of gas under higher pressures, and cited the experience of a gas company at Danbury, Conn., in support of his claims. In our issue of April 12, 1900, we abstracted another paper by the same author, describing a 3-in. main between Phoenixville and Royersford, Pa., carrying gas under from 10 to 20 lbs. pressure, which Mr. Shelton had been instrumental in building. In both of the issues named we discussed the subject approvingly in our editorial columns. The idea is so promising in a variety of ways that we are glad to see that it was brought up again at the recent meeting of the Western Gas Association (where the subject was first broached by Mr. Shelton a year ago). Mr. Shelton, on request, introduced the subject by reviewing briefly his two former papers and expressing continued confidence in the plan, as is most eloquently shown by his statement that a second and third high-pressure installation is now under way. The main line pressure regulator, reducing the pressure from 20 lbs. (or less, as the case may be), to 0.2 or 0.1 lb. water pressure, has worked so satisfactorily after a month or two of adjustment at the start, "that the Bristol recording gage simply describes a perfect circle every 24 hours."

The gas in question is a water gas of 20 to 22 c. p. At the start it was pumped into the older holder at Royersford, but Mr. Shelton now says that for three months the holder has not been used, the gas passing from the regulator directly to the old low pressure mains. Mr. Shelton concluded his remarks with the following observations as to the safety of the plan:

It is, of course, obvious that one cannot afford for a single second to have high pressure get on a common tin meter in the cellar of a consumer. Serious accidents happened in the early days of using natural gas by reason of such things; and you cannot afford to run any risk of that sort. A very simple device, costing only 50 cts., will make one perfectly safe in that respect. You can place a safety seal by which the high pressure gas, if any chances to get by the service mechanism, will pass into the atmosphere and not into the primises. With that, and with such a seal on the main pipe running into the town, you will have precautions like those taken by the natural gas suppliers, and I believe you will secure entire protection. I think I can say that the query I propounded a year ago—why should we not with advantage reduce our cost of distribution by the use of pressure instead of diameter in the distributing system—is very largely solved. I believe we have solved the inquiry in the past year for a great many, and for a majority, of the situations in this country.

Mr. Shelton's address was followed by quite an extensive discussion, during which several additional instances of piping artificial gas under comparatively high pressures were related. It was stated that at Louisville gas had been pumped from the works to the holder under 5 to 10 lbs. pressure, with no trouble from condensation and no necessity for drips. At Clinton, Mo., a high-speed blower has been used six months to raise the initial pressure on the mains from 3 to 6 or 7 ins. without trouble, relieving the company "from the apparent necessity of laying large distributing mains for a long time to come." At Chicago, 10 lbs. pressure has been used on a main of the old Mutual Gas Co., the main being 8 ins. in diameter and 23,450 ft. long, leading from the works to a storage holder.

Mr. John A. Britton, Manager Oakland Gas Light & Heat Co., gave the following as his experience in the matter under discussion:

For nearly ten years I have operated on the Pacific Coast a pipe line eight miles long, sending gas through an 8-in. pipe from one city to another, under an average pressure of 5 lbs. There has been no appreciable leakage along the line during that time. Condensation occurs only at two points, where the pipe crosses a water way. There we have drips. In connection with that pipe line, which is used only in the day time to fill a holder in a town directly across from Oakland, the city in which I live, I use a pump running at night to supplement the pressures in the territory lying about seven miles from our holder, and supplying a territory covering possibly 25 sq. miles. The pressure at the further end of that district last winter, before I put in a balancing governor, was about 0.8 only; but by the use of that pump alone, pumping through the balance governor beginning at 3 ins., it has gone up to 2 lbs. When used in the night time I have raised the pressure in our district to 20.4 (ins. ?) at its extreme end, which would be, from the balancing governor to the extreme end of the pipe, about 3½ miles. There has been no difficulty in any way in connection with it in all these years. I will say, for the good of the photometric tests, that at the extreme end of the line, at the holder, there has not been the depreciation of a quarter of a candle in the gas delivered. I agree with Mr. McDonald that the hydrocarbons are taken up and carried forward, if any are deposited.

We have abstracted the foregoing from "The American Gas Light Journal" for June 4, which has an apparently full account of the discussion, including much incidental matter bearing more or less directly on this general subject.

A NEW MASTER CONTROLLER SYSTEM for operating electric trains, developed by the General Electric Co., of Schenectady, N. Y., under a patent issued to Prof. Elihu Thompson, has recently been tried on the tracks of the Boston Elevated R. R. Co. Each car carries a main controller, consisting of a number of magnets which operate contacts controlling the current through the motors. These contacts are provided with the usual magnetic blow-out. This controller is placed under the car. On the platform of each car is a master controller, through which pass only the currents needed to operate the magnets of the main controllers. A train cable with couplings between the cars connects the magnets of all the main controllers of the train in parallel. Consequently, all the main controllers of the train may be operated from any master controller. As the master controllers are supplied with current from the third rail, all the main controllers are opened if from any reason the current is cut off.

AN ELECTRIC CENTRIFUGAL PUMP is used at the water-works of Coulouvrenier, near Geneva, to lift water to a height of 460 ft. The pump was made by Sulzer Bros., of Winterthur, Switzerland, and is driven direct by means of two-phase asynchronous electric motors of 1,000 HP. The pressure is obtained by a simple tandem arrangement of two centrifugal vanes, says "The Engineer," and injectors are employed to fill the pumps, which are started up with closed valves. As a result, the motor in starting has only the friction of the water to overcome. When the normal speed of 600 revolutions per minute has been reached the valve is slowly opened and the lifting begins. The pump delivers 5,000 gallons per minute, corresponding to a useful output of 700 HP.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXI-XXIII. *New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.*

Prof. Henry Morton, of the Stevens Institute, lays open another fallacy of the liquid-air promoters by demonstrating in the Stevens "Indicator" that there is nothing in their claim that the liquid-air process may be used as a means of producing cheap oxygen gas. Liquid air substantially retains the same proportions of four parts of nitrogen to one part oxygen that are found in ordinary air. But as the liquid air evaporates, the nitrogen escapes faster than the oxygen, and after a time what is left is mainly pure oxygen. This much is admitted, but now the cost must be considered. Prof. Morton quotes Mr. Tripler as figuring the cost of liquid air at 20 cents per gallon; and as it takes five gallons of liquid air to make one gallon of oxygen the latter costs $1.00 per gallon. This gallon of oxygen, on expanding to atmospheric pressure, would occupy about 104 cu. ft.; and therefore 1,000 cu. ft. would cost about $10.00. While the cost of manufacture could be reduced by processes for utilizing the cold from the escaping nitrogen and that from the vaporizing oxygen, there are no data for computing the extent of this reduction.

But, says Prof. Morton, with the oxygen produced at less cost than by present processes, what will you do with it when you get it? It is now chiefly employed for lime lights in theatres and for stereopticon exhibitions, and its present use is therefore extremely limited. The promoters suggest, however, that this oxygen may be substituted for air in ordinary processes of combustion, under steam boilers, in iron furnaces, etc. But the cheap oxygen would here have to compete with the cheaper "free" atmosphere, and the cost of storage and transportation would be prohibitory. Prof. Morton then takes up the claim that 40 per cent. of the coal now burned under the boilers of a steamship could be saved if oxygen were supplied in place of air in burning this fuel. He says that every ton of coal would require 2½ tons of oxygen to consume it; and as this oxygen would have to be carried in strong steel cylinders there would be a fatal reduction in cargo capacity on the steamship thus "economically" equipped. As regards bulk, the carriage of the compressed gas would demand ten times the bunker capacity of, say, the 2,000 tons of coal usually allowed to carry a large ship across the Atlantic. If the gas were not compressed, then each ton of coal would require 66,000 cu. ft. of gas; or, about 132,000,000 cu. ft. to burn the 2,000 tons of coal referred to. Assuming that the 40 per cent. of fuel was saved, as claimed, to save it would require the transport of 22 gas holders the size of those on the banks of the Hudson at New York, each of which holds 3,500,000 cu. ft. To manufacture the oxygen on board the ship would demand machinery equaling in bulk that used to drive the vessel. Prof. Morton also suggests that these promoters should study the effect of the combustion of fuels of any sort in oxygen, with the enormous intensity of heat developed. A furnace so fed would melt up or burn out in short order, owing to the destructive intensity of the temperature. Altogether, therefore, the latest claims of the liquid-air promoters are as impracticable and absurd as have been most of the others which they have made.

The Treasury Bureau of Statistics has recently sent out an abstract of a valuable series of statistical tables, issued by the Swedish Government, accompanied by an interesting discussion of some of their principal features, by Mr. Constable, the British Consul at Stockholm. These tables cover, in 5-year periods, the commerce and production of the world, and Mr. Constable, in his thorough analysis of the gains and losses made, presents a vivid picture of the rapid growth of the chief producing and commercial interests of the United States, as compared with other great nations. This analysis, coming from the source which it does, is especially interesting.

Commencing with pig-iron we find the chief producing countries given as France, Germany, Great Britain and the United States. The gains and losses between 1871 and 1895 can be set forth in tabular form as follows for the average annual production in 5-year periods:

	1871-5.	1891-5.
France, tons	1,265,000	2,006,000
Germany, tons	1,946,000	5,082,000
Great Britain, tons	5,562,000	7,361,000
United States, tons	2,284,000	8,263,000

Commenting upon this table, Mr. Constable points out that in this period of 1871-1895 Great Britain's proportional share in the world's production of pig-iron has decreased from 46.3 per cent. to 27.3 per cent.; while in the same period the United States has increased its proportion of output from 16.1 per cent. to 30.9 per cent. In iron ore production the average annual output of the United States, in the period 1891-5, was 14,288,000 tons, as compared with 12,249,000 tons for the United Kingdom, 11,679,000 tons for Germany, 5,346,000 tons for Spain and 3,651,000 tons for France. The ore production in 1871-5 was 16,087,000 tons per annum for Great Britain and Ireland, and 4,532,000 tons per year for the United States. In coal England is still ahead, with a gain from 126,972,000 tons to 184,819,000 tons per year, in the period 1871-95. In the same time Germany has increased her coal output from 44,680,000 tons to 97,008,000 tons per annum; while the United States shows an increase from 45,283,000 tons per year in 1871-5, to 160,832,000 tons in 1891-5. From this statement it appears that in 1871-5 England supplied 47 per cent of the world's output of coal; in 1891-5, England furnished 34 per cent, Germany 17 per cent., and the United States has advanced from 17 to nearly 30 per cent.

In the consumption of raw cotton, given by periods extending back to 1830, Mr. Constable shows that while Great Britain's consumption of cotton increased from 1,590,000 tons per annum in 1831-40, to 7,091,000 tons per year in 1891-4; that of the United States increased from an average of 376,000 tons per year, in 1831-40, to 5,522,000 tons annually in 1891-4. Since 1870, says Mr. Constable, the consumption of Great Britain has increased by one-fourth, while that of the rest of Europe and the United States has doubled. In railway construction in the last 25 y[illegible] the United States is very far ahead. The e[illegible]ated increase in length of line in these years [illegible]iven as follows, for the period 1870-95: Gain [illegible]reat Britain and Ireland, 5,580 miles; in Rus[illegible] 15,190 miles; in Germany, 17,127 miles; in [illegible]nce, 13,941 miles; and in the United States, [illegible]8,340 miles. The analysis of Mr. Constable sh[illegible] that of the total production of wheat through[illegible] the world the proportion of the United States i[illegible]arly one-fifth; that of the British Colonies is m[illegible] than one-eighth; while Germany produces le[illegible] than one-twentieth of the total. The United S[illegible]s is set down as producing about 22 per cent. [illegible] the world's annual output of gold and over [illegible] per cent. of the total silver; while the United [illegible]ates and the British Colonies together furnish [illegible]ore than one-half of the annual gold produ[illegible] and nearly one-half of the silver mined each y[illegible].

The commerce of nations, including impo[illegible] and exports, is particularly interesting to the p[illegible]e of the United States at this time, as here we have yet something to gain; and the gain is rapid. The statistics quoted place the average annual value of the total commerce of the United King[illegible]m at $2,869,444,440 in 1881-5, and at $2,945,83[illegible]0 in 1891-5. The figures for Germany for these same periods are $1,533,055,555 and $1,763,888,875, while those for the United States are $1,511,666,665 and $1,736,666,665. As Mr. Constable says, during this period England's trade has increased by a little more than 2½ per cent., while that of both Germany and the United States has gained each 15 per cent.; the trade of France has steadily declined since 1881. It should be noted that the actual volume of trade has increased to a greater extent than these figures would indicate, as there has been a decided and almost universal fall in the prices of commodities in the period 1881-1895. In population, these tables place the percentage of increase in the last ten years at 24 for the United States, 12 for the British Colonies and dependencies, 12 for Germany, 11 for Russia, 8.77 for Great Britain and Ireland and only 0.78 for France.

The experience of an American lately residing in Berlin is interesting as showing the impartial and intelligent manner in which the fire ordinances of that well-regulated city are applied and enforced. According to the New York "Times," this gentleman occupied the third floor of a four-storied building; and one morning found a fire smoldering down through the ceiling of his dining-room. He rushed to the nearest fire-box and turned in an electric alarm; but on his way back to his house he was courteously stopped by a policeman, and, notwithstanding his appeals to be allowed to get back to his wife and children, he was compelled to give his name, occupation, address, etc. A second policeman was sent to the house to ascertain if there was a fire; and by this time the engines and firemen appeared. The fire was quickly put out with chemical engines; the firemen then swept up the rubbish and carried it away, and actually scrubbed the floor of the room upon which part of the ceiling had fallen. Meanwhile the officers of the department took notes and made diagrams of the location of the fire; and finally left the place clean and in good order, saving only the damage to the woodwork and plaster.

The next step was to ascertain who was responsible for the fire, and the tenant was summoned to the police court for examination. It appeared that the fire owed its origin to an incandescent fuel-brick that had fallen from a stove in the attic, set fire to the floor, and burned its way through the ceiling. It was found that a zinc under this stove was some inches narrower than the law provided, and an inquiry was started to find out who was responsible. The tenant declared that he leased the premises as they were; and the owner was then called, who testified that he had just acquired the property by purchase, with the stove in place. The owner was then set aside and the previous owner was called and put through a searching examination. It was shown that he caused or permitted the stove to be set up as it was found; and he was promptly assessed a sum suffi-

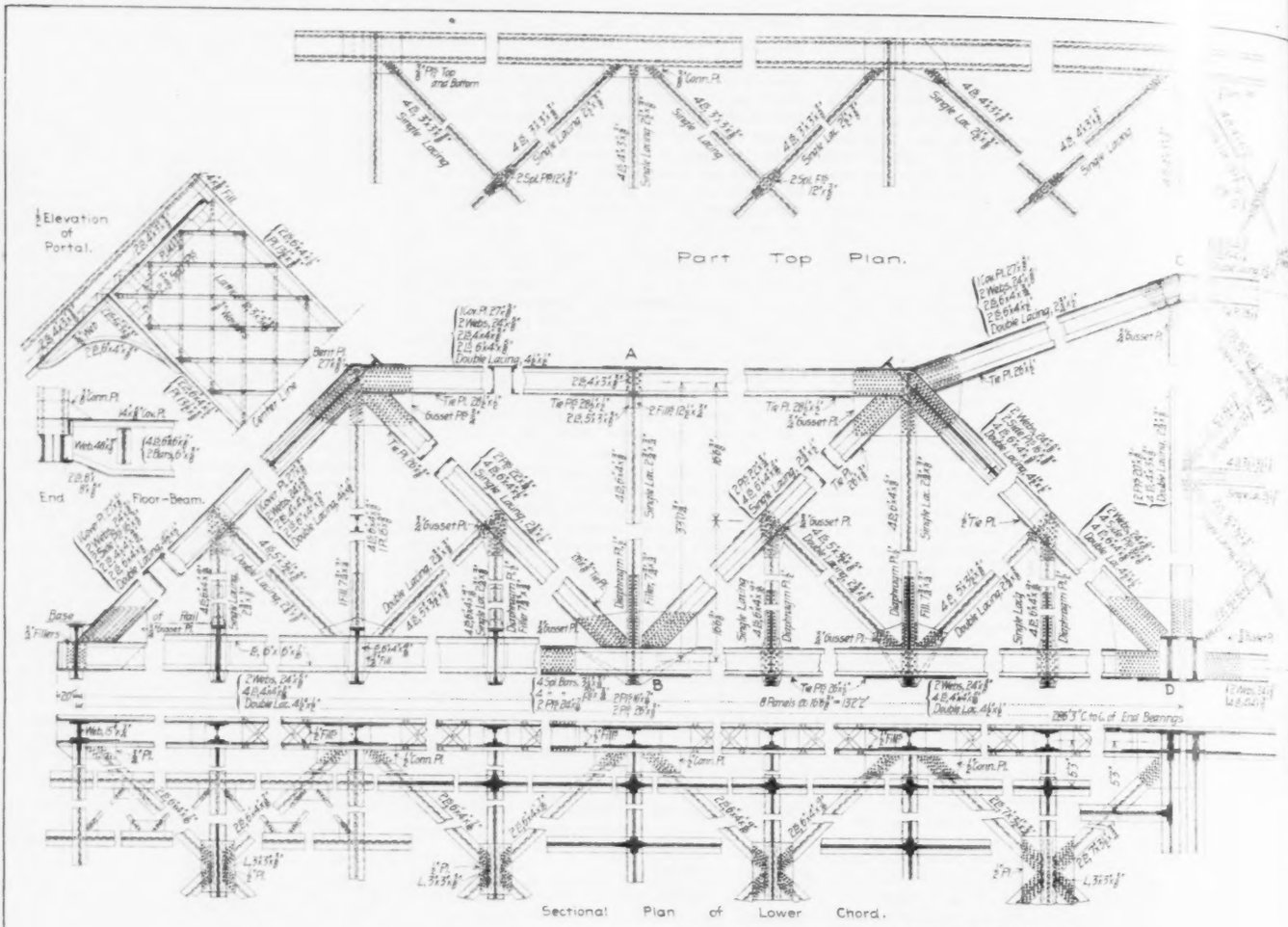


FIG. 3. HALF ELEVATION, PLAN AND SECTIONS OF SWING SPAN.

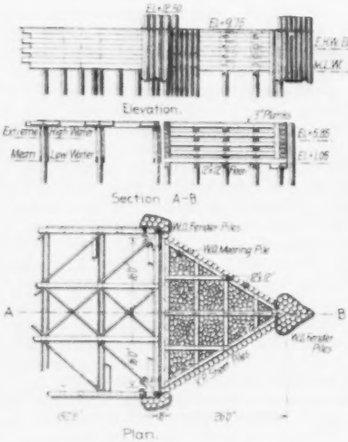


FIG. 8. FENDER CONSTRUCTION AT WEST END OF DRAW REST.

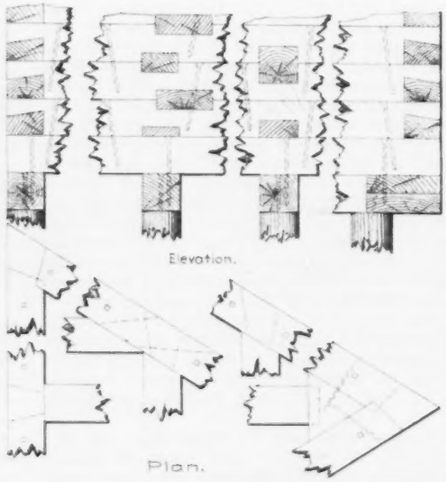


FIG. 9. DETAILS OF CRIB CONSTRUCTION FOR WEST END FENDER OF DRAW REST.

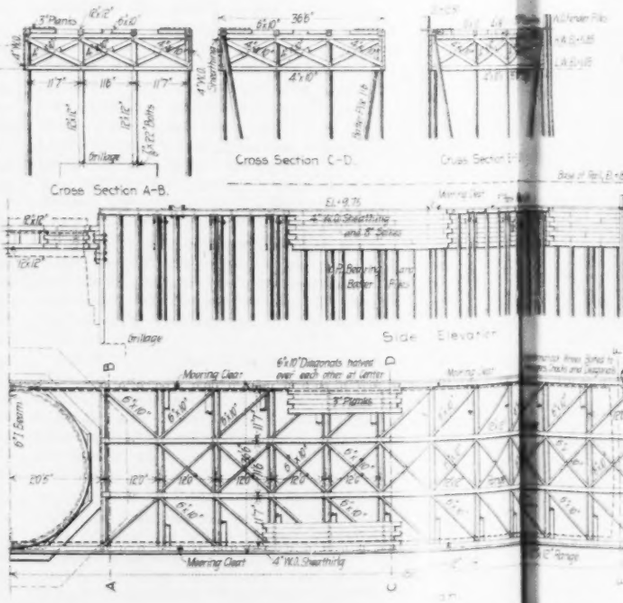


FIG. 7. TRANSVERSE SECTIONS, PLAN AND SIDE ELEVATION OF EAST HALF

SWING SPAN OVER SPUYTEN DUYVIL CREEK, NEW YORK.

Wm. J. Wilgus, M. Am. Soc. C. E., Chief Engineer.

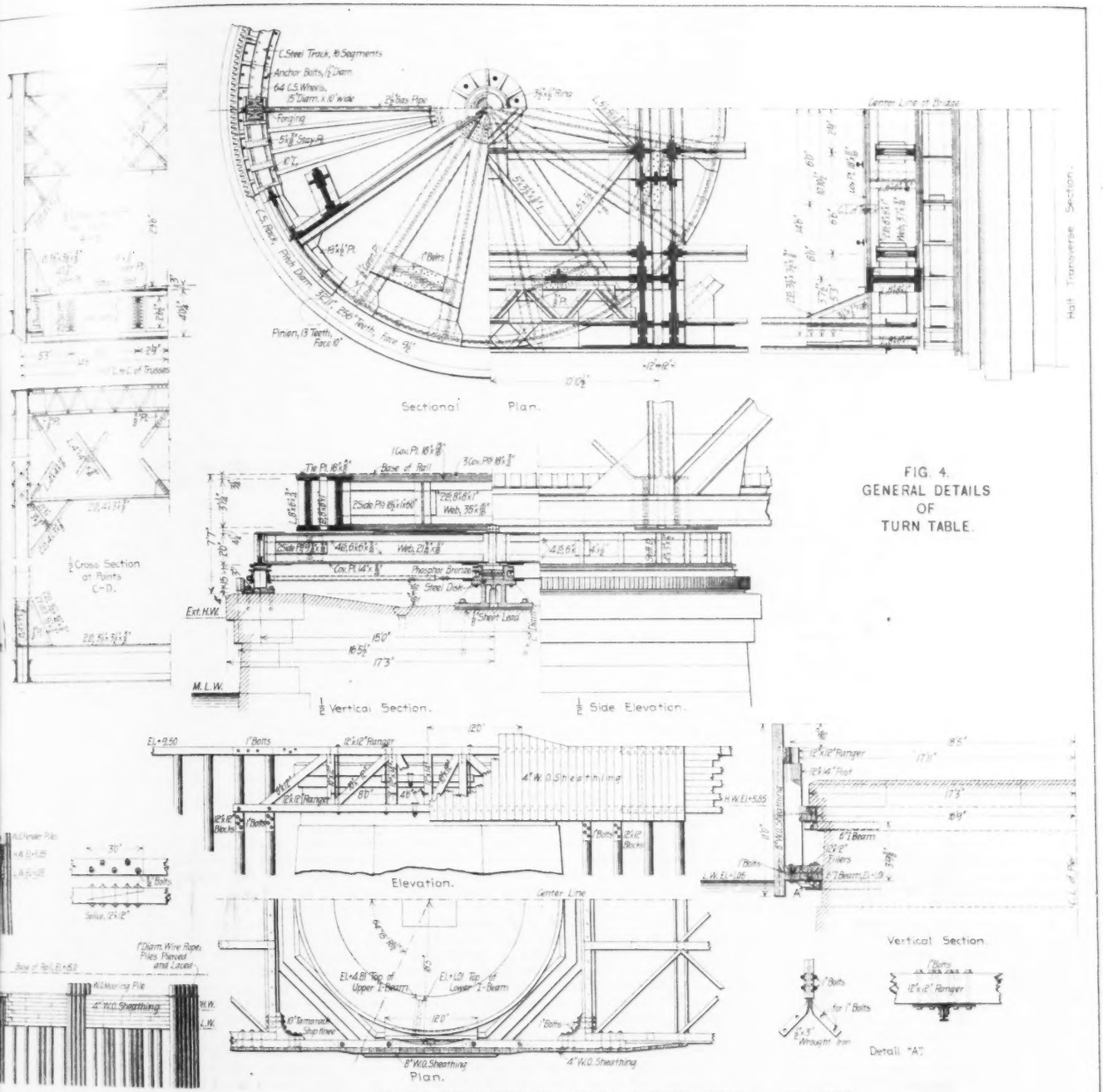
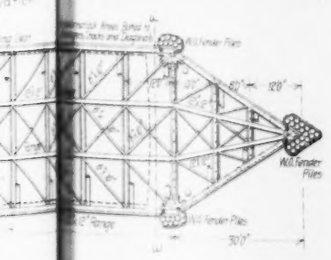


FIG. 4.
GENERAL DETAILS
OF
TURN TABLE.

FIG. 12. DRAW REST AND FENDER CONSTRUCTION AT PIVOT PIER.



ELEVATION OF EAST HALF OF DRAW REST.

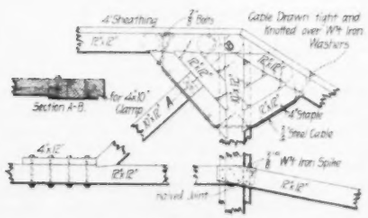


FIG. 10. DETAILS OF SHOULDER FRAMING AT EAST END OF DRAW REST.

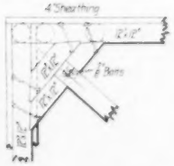


FIG. 11. DETAILS OF CORNER FRAMING AT WEST END OF DRAW REST.

REEK, NEW YORK CENTRAL & HUDSON RIVER R. R.

Robert Giles, M. Am. Soc. C. E. (late), Assistant Engineer.

CHAS. HART, LITH., 26 VESEY ST., N. Y.

cient to cover the cost of calling out the fire department was made to repair all damages to the house, and was in addition fined 300 marks for violating an ordinance relating to the prevention of fires in buildings.

Compared with our own departments the Berlin fire department is not well organized; its men are slow to arriving to a fire, and their leisurely methods are a laughter in the American spectator. In the matter of enforcing ordinances intended to prevent fires, however, we evidently have something to learn from these same German officials. As stated last week, in commenting upon mutual insurance companies, nine out of ten fires in factory buildings are due to a lack of apparatus for putting out fires, or to sheer negligence and lack of system. The experience of the insurance companies mentioned proves that regulations can be framed to meet these conditions, and, moreover, that these regulations can be enforced. In the light of the very successful experience of this insurance system there can be but little doubt that in the case of tenants and owners of residential buildings as well, the rigid enforcement of ordinances covering construction and negligence, and the quick punishment of those violating these ordinances, would have a very material effect in decreasing the number of fires. We have laws that cover some of these points; but we want a little German method in enforcing them.

UNIFORM ACCOUNTING A PREREQUISITE TO NATIONAL MUNICIPAL STATISTICS.

One of the greatest drawbacks to municipal progress is the lack of correlation and co-operation between the different departments composing city governments and the still lesser degree of co-operation between cities as a class. Although this is true to a large extent the world over it is more strikingly so in America than in some other countries, owing largely to our lack of central administrative control, both in city and State. In England, which in many respects is less highly centralized than other European countries, we find nearly all municipal functions in the hands of councils, while the actions of those bodies are controlled to a marked degree by the Local Government Board. In the United States the control of public works by city councils has been in inverse proportion to the number and magnitude of the works in hand; that is, one branch after another of municipal service has been cut off from the council and entrusted to separate commissions, until it is not thought strange here to find a single city with water, sewer, street, fire, health and lighting departments, entirely separate and independent of each other and of the city council, except that some, but by no means all, of these departments may be compelled to look to the council for appropriations.

As between the several municipalities* of a single State there is often scarcely a common tie, save that each and all are under the same constitution and the control of the same legislature. Most of the constitutions, however, were drawn before our cities attained to anything like their present rank; and the cities and towns are operating, in so many instances, under special charters and acts, that a common legislative control means comparatively little in common after all. Cities in different States of the Union have absolutely nothing in common, of necessity, except a few rights to individuals guaranteed by the Federal constitution.

When our cities were small all these dissimilarities were of little moment; in fact, many of them did not come into existence until brought out by the enormous municipal development of the last few decades. But with the growth of municipal functions, correlation and co-operation are becoming of the greatest importance; otherwise progress is retarded by useless and easily avoidable friction between departments of the same city and between rival cities and towns, and both municipal departments and different municipalities will fail to profit by the experience of predecessors in the same or similar paths.

*Municipalities, in the broadest sense of the word, includes the minor civil divisions of a state—counties, cities, towns, boroughs and villages. There is a strong tendency, however, to restrict the word to urban, as contrasted with rural communities.

One of the greatest opportunities for advance is a thorough-going reform in municipal accounting, notably in the direction of uniformity. The need for uniform municipal accounting is becoming more and more evident. It is forced home upon every committee and official appointed to learn how other cities and towns are solving a given problem; upon every convention of municipal officers; and upon such governmental departments of the State or nation as undertake the collection of information relating to cities. The deplorable lack of uniformity found by all investigators is not confined to differences between states nor cities, but extends to the various departments of almost every city and village in the land; nor does it stop here, for it is a common thing to find a single department changing the plan or scope of its bookkeeping year after year.

It seems obvious enough that a water-works, sewerage or lighting department of a city must follow a well-conceived plan of accounting year after year if it is to know where it stands and judge of the success or failure of both old and new methods of work. Yet the vast majority of municipal departments have wofully deficient systems of bookkeeping at the outset and annul a large part of the value of those by frequent changes and omissions of details, and even suspensions of accounts. In thousands of cases, departments of more or less importance really keep little or no more than a cash account, subdivided, perhaps, to correspond roughly with the various branches of the department, but with entries most unsystematically distributed to the branch accounts whenever the slightest complexity arises. Charges against or in favor of another department are comparatively rare; or if made are mere debit or credit items in a general cash account. If a water department supplies cast-iron pipe from its stock to the sewer department no entries may be made on the books of either department; while if cash is paid for the pipe it is likely to be entered with the ordinary receipts (revenue from water consumers) of the water department and stands only a fair chance of being properly accounted for in the sewer department. But if, instead of pipe, the water department supplies water to the public schools, sewer, fire and street departments probably in nine cases out of ten the water department gets no credit whatever for the services rendered. This is a serious matter, particularly in the case of the fire department, since a large part of the original cost of a water-works system, and hence of its capital charges, is due to making the works ample for fire protection, and therefore should fall upon the property benefited, rather than the water consumer. If the burden were properly distributed it would be easier to raise funds to improve the character of the water supply and also to reduce water rates, so the blessings of pure water would be extended and the health of the community greatly increased.

These are only a few of the evils of haphazard accounting as affecting single departments. Others, and plenty of them, will occur to any intelligent observer on a moment's reflection, chief among which may be mentioned the uncertainties surrounding the great problems of municipal ownership*, the contract as against the day-labor plan of carrying out municipal works and the agitation for a "living wage," which is getting to mean $2 a day for eight hours labor on all municipal work. How can such momentous questions as these be decided when a city fails to keep its accounts in such a manner that even the first cost of its lighting plants, water-works, sewers or streets cannot be ascertained, much less the respective operating expenses?

Where such confusion exists in single departments the evils are increased when the city as a whole is considered. One department can learn little or nothing from the experience of another, because the accounts of each are improperly kept and there is no attempt at keeping any of them on a comparative basis. It being next to impossible, if not quite so, to ascertain the real financial standing of a single department, the status of the whole city is a hopeless problem. What this means in rates of interest and premiums on bond issues, and in contract prices for materials and supplies, no one can estimate, but it is safe to say that there are not many cities in the United States where needed reforms or improvements in accounting would not save their cost many times over each year in the reduction of interest charges and contract prices. In fact, hundreds of cities would save money in their accounting departments alone by the introduction of improved methods.

*See "Uniform Accounting for Gas and Electric Lighting Companies," elsewhere in this issue.

When it is so difficult to harmonize the accounts and compare the results of different departments of the same city, attempts to profit by the experience of other cities, so far as it is shown by statistical and other reports, are almost hopeless. The task of collecting information from a few neighboring cities is discouraging in itself, but when attempts are made to compare the meager data obtained so many discrepancies are found that hope yields to despair. At least, such is the case with the trained statastician; but unfortunately the council committees that undertake so many of these investigations are rarely trained statisticians or appreciative of the value of such persons; so the figures are put together somehow and made to fit a preconceived or ill-conceived theory and money and perhaps human lives are sacrificed as a result.

A consideration of uniformity in municipal accounting is timely just at present, when the attention of the whole country is turned to our twelfth national census. It has been urged by a number of organizations, of late, that the present census should include comprehensive inquiries relating to municipal affairs. Thus far, all requests of the sort addressed to the Census Bureau have been met with the general statement that under the statute governing the present census municipal inquiries cannot be taken up until the schedules of population, vital statistics, agriculture and manufacturing have been completed, or until about 1902.

As we pointed out in our issue of July 27 in an editorial on "Municipal Statistics in the Census of 1900," the act providing for the twelfth census is so broad in this particular that

> it would seem as though the only limitations on the scope of the municipal inquiries for the next census would be the wishes of the director, the funds at his disposal, the inherent difficulties of the task and matters of general expediency.

To our mind the greatest of the "inherent difficulties of the task" is the lack of uniform municipal accounting. If this be true, the advocates of including detailed municipal inquiries in the next census should bend their energies towards the removal of this obstacle. That it is time we think no one who has examined many departmental reports of American cities and towns will deny. As an example of what may be learned by this sort of experience we may cite the following: In the editorial mentioned above we stated that the U. S. Department of Labor had been authorized by Congress to collect and publish statistics for cities of 30,000 population and upwards. The result of the first attempt was issued a few months after the date of our editorial.* In the introductory remarks to this bulletin it is stated that the act authorizing the inquiry evidently contemplated a compilation of statistics from municipal reports. On request, many of the officials concerned sent their reports, but some cities stated "that no printed reports were available, while in other cases no reply whatever was received." But this was only the beginning of the difficulties encountered, for:

> An examination of the reports received showed that very few facts were reported uniformly by all the cities, and that even the important financial statements were presented in so many different forms as to preclude such classification of the various items as seemed necessary for a satisfactory comparison. * * * * * Even had the Department been furnished with the reports for all the cities within the limits of the investigation, the many difficulties encountered in a tentative effort with the reports already received led to the conclusion that uniformity and accuracy could only be secured by sending the special agents of the Department to the cities for the data desired. * * * * In many cases the methods of bookkeeping in vogue made a uniform classification of financial items, as called for by the schedules of the Department, very difficult and required much time and labor.

This inquiry covered only 140 of our largest cities, in which accounting systems above the average might be expected. It was conducted by "special agents," presumably of at least fair training in such work. Therefore all persons with a vivid imagination can picture for themselves the difficulties involved if census enumerators with

*"Statistics of Cities," Bull. Dept. Labor, No. 24, Sept., 1900. Edited by Carroll D. Wright, Comr.

qualifications similar to those employed in the past were to undertake to cover the 3,500 to 4,000 communities in the United States having public water supplies, or even the cities and towns of 4,000 population and over, of which 905 were shown by the census of 1890. Again, we say, that the advocates of national municipal statistics should at once bend their energies towards securing uniformity in municipal accounting.

The postponement of the municipal schedules of the twelfth census until 1902 or later, affords an opportunity to make a fair beginning for uniformity. A number of national societies have been working to that end for years and others have taken up the subject within the past year—some within a month or so. In addition, a few States have enacted laws providing for the State audit of municipal accounts, or for reports of municipal receipts and expenditures to a State officer, in accordance with forms prescribed by the latter. Vital statistics are now gathered in a satisfactory manner by a few, and in some fashion by most of our State boards of health, or some allied body, and street railway statistics by a number of State railway commissions. The Massachusetts' Gas and Electric Light Commission has gathered valuable facts and figures regarding all the municipal lighting plants of Massachusetts (regardless of ownership). State boards for the equalization of taxes collect figures relating to assessed valuations and tax rates in many States, and the corporation returns in a number of States include figures, often meager enough, from companies operating under municipal franchises. All these State boards exact something in the way of uniform returns and thus tend to uniform municipal accounting, while a few of them have made notable achievements in that line. The number and efficiency of such boards may be increased by showing legislators that their work is appreciated and in demand, and by impressing on the general public the fact that such work conserves instead of destroys municipal home rule, individual rights and personal property by diminishing legislative interference. Uniform accounting may also be furthered by extending and encouraging the efforts to that end already being made by such organizations as the New England Water-Works Association, the American Society of Municipal Improvements, the National Municipal League, the National Electric Light Association, and doubtless other bodies. City officials, at least those in charge of engineering works, will find that by adopting the forms recommended by one or another of the societies named they can contribute to uniform accounting in their very next annual report, for already forms have been adopted by one body or another for water-works, sewers and streets, while a tentative form for both gas and electric lighting plants was proposed by Mr. Jas. B. Cahoon, now President of the National Electric Light Association, at the recent meeting of that organization.* In a subsequent issue we hope to show in more detail what has been accomplished in the way of uniform accounting and in the collection of municipal statistics.

LETTERS TO THE EDITOR.

The Manufacture of Portland Cement from Blast Furnace Slag.

Sir: In your issue of June 7, in which is included an article the writer prepared on the Michigan Alkali Company's cement plant, we notice you refer to the matter in an editorial, and state that, as far as you know, this plant is the first erected in this country to produce Portland cement from caustic soda waste, which is correct. At the end of the editorial, however, you state that it is not the only instance in which waste products are successfully utilized for manufacturing Portland cement, and you note the works of the Illinois Steel Co. as being the only one which manufactures Portland cement from furnace slag. We think you are misinformed in making the statement, as the first plant in this country to manufacture a true Portland cement from blast furnace slag and limestone, was designed and erected in Pittsburg by ourselves for the Clinton Iron & Steel Co. in 1898. The plant was put in operation in January, 1899, and has been running continually ever since. The cement is manufactured from an intimate mixture of pulverized furnace slag and limestone, and the dry raw material is burned in the rotary kiln with pulverized coal as a fuel. The cement plant of the Illinois Steel Co. was not built and put in operation until after the experimental plant which we were erecting at the Clinton Iron & Steel Co.'s works had been completed and the process had proven a success.

Yours very truly,

Lathbury & Spackman.

Philadelphia, Pa., June 8, 1900.

*See an abstract of Mr. Cahoon's paper, elsewhere in this issue.

Determination of Tangent Bearings, New Croton Aqueduct Survey.

Sir: In the article upon the alinement of the New Croton Aqueduct appearing in your issue of May 31, the bearings of the tangents are given to the fraction of a second. I should be glad to know how this was determined with the instruments used, and also the object of such refinement where the agreement of two settings of a rod, 300 ft. distant, within ¼ or 1-16 in., was considered satisfactory. The former difference would correspond to seven seconds of arc approximately. Possibly there is some point that has not been brought out in the article.

Subscriber.

Spartanburg, S. C., May 31, 1900.

(In accordance with our usual practice we submitted our correspondent's letter to the author of the article referred to and present his reply to it below.—Ed.)

Sir: In reply to "Subscriber's" inquiry as to how the angles referred to were measured to fractions of a second, I would say, in the usual way, by repetition and division.

It may seem strange to one who has never tried it, that two transitmen each endeavoring to produce a given straight line a distance of 300 ft., should differ as much as 1-16-in. in their locations. I can assure him, however, that unless the utmost care be taken, they will find it difficult to agree within a much greater fraction. It must be borne in mind that in the work described in my paper, each observer set his points entirely independent of the other. Had the sighting pole been held on the point established by one for the purpose of being verified by the other, they would probably have agreed exactly on every point. It is quite another thing when the pole is held away from the point, and the second observer is required to set it afresh in the line of sight. He cannot even exactly agree with himself, except by accident.

E. Sherman Gould.

Yonkers, N. Y., June 5, 1900.

Stray Notes of Travel.

(Editorial Correspondence.)

Fast Vessels and Slow Vessels.

When one speaks of the transatlantic voyage having been reduced to six days or five days, the natural idea is that the time from port to port is meant. Actually, however, the time is reckoned from the last communication with the shore, by letters or telegrams delivered to the pilot as he leaves the vessel at Sandy Hook Lightship, and the first touch with the world again on the other side of the ocean, where a steam tender comes out from Queenstown, Ireland, to deliver and receive mail, passengers, etc., while the steamer lies to off Daunt's Rock Lightship.

There is a more or less prevalent idea that the duration of the transatlantic voyage will be still further reduced to a considerable extent. It is difficult to see how this can be brought about. A few years ago the Cunard, White Star and American lines were all competing in the transatlantic race. Now all these companies are content to let the North-German Lloyd and Hamburg-American lines struggle for the record. These two companies may, perhaps, succeed in reducing the time to four days by one or two crack vessels; but it is not likely that their example will be followed or that the average time of the average transatlantic voyage will be materially lessened for a good while to come, barring, of course, some revolutionary inventions or discoveries that cannot now be foreseen.

The long and the short of it is that, save for its advertising value, very high speed at sea doesn't pay. It costs more to reduce the transatlantic voyage from ten days or eight days to five days than the traveling public is willing to pay. These ocean greyhounds are coal eaters. Nearly the entire space in the hold is taken up with boilers, engines, and coal bunkers, and only a very small amount of cargo can be carried. The "Campania" of the Cunard Line, for example, burns 500 tons of coal per day, or about 3,500 tons in a single voyage. The supply taken on at New York will probably remain stationary in price for many years to come, but the price of coal taken on in England for the return voyage has been sharply advanced in the past few years, and the advance is pretty sure to be maintained and on the whole increased as time goes on. Any possible advance in marine engine economy can only partially offset this increase in the cost of fuel; and I suppose it need hardly be said to the readers of Engineering News that neither liquid air nor liquid moonshine nor any other fad of the popular imagination can replace the energy stored in fuel as a source of motive power on the sea.

The vessels that are paying best profits to the transatlantic lines are those of the type of the new "Minneapolis," of the Atlantic Transport Line; the "Pennsylvania," of the Hamburg-American Line, or the new "Ivernia," of the Cunard Line. These are vessels able to carry 10,000 to 15,000 tons, or even more, of paying cargo, and yet with accommodations for perhaps [illegible] as many cabin passengers as the grayhounds. The[illegible]ing vessels make the passage in 10 to 14 days, burn [illegible] 75 to 100 tons of coal a day—a sixth or less of th[illegible]ed by the record-breakers—and are preferred by m[illegible] passengers on account of their great steadiness and th[illegible]edom from the jar and tremor of the machinery, whi[illegible] noticeable more or less on all the high-speed boats.

In ocean carriage, as on land, the great [illegible] of the receipts must go to pay expenses in any eve[illegible] and it can be readily understood how a vessel which [illegible] so much less coal and earns so much more from fr[illegible] than the grayhound, should be more provocative of di[illegible]ends.

Steamer Shafts.

The engine-room of a steamer is a fascin[illegible]g place to an engineer on his way abroad, and he w[illegible]usually be able to obtain admission to it, although fe[illegible] passengers go there, or for that matter would care to visit a place so hot, noisy and, to the careless man, da[illegible]erous. No other machines in the whole range of man's construction develop such enormous power as the engine[illegible] of a transatlantic grayhound, and the narrow space [illegible] which this vast energy is put forth makes the feat o[illegible] engineering design all the more wonderful. We speak glibly of 25,000 or 30,000 HP.; but the imagination fails to grasp what such an amount of energy represents. With the ship moving at its full speed and allowing an average efficiency for the engines and propeller, the vessel is actually pushed forward through the water with a steady force of 125 to 150 tons. Such a power could toss a fair-sized locomotive 100 ft. high every second.

Great as this force is, however, as one looks at the huge steel shafts that transmit the power to the screw they seem ample to bear any strain that can possibly be put on them. These great steel cylinders,as big around as a barrel and running so true that to the eye they appear to be stationary, would seem "an irresistible body," so far as the wit of man can devise one; yet, there is no more serious problem in marine engineering at the present day than the breakage of propeller shafts. The "percentage of fatality" among propeller shafts—if one may so term it—has become enormous. The number broken annually now numbers several hundred; and such an accident always involves considerable danger to the vessel. Of course the great proportion of these accidents occur to freight steamers of the tramp class; and the cause is generally ascribed—probably correctly—to the practice of sending out such vessels with so little ballast that the propeller is only partially submerged. Whenever the sea is rough, the propeller is half the time out of the water. The engines race, and put strains upon the shaft that cannot be calculated or provided against.

It is not the tramp steamers alone that suffer, however, as witness the recent accident to the "New York," of the American Line. Other notable cases have occurred in recent years of the breakage of shafts on passenger steamers, and it is not at all improbable that to accidents of this sort is often due the loss of vessels which sail from a port and are never heard of afterward.

In considering the causes of screw shaft breakages, it seems to the writer that attention should be paid to the transverse strains which are brought upon the shaft by the deformation of the hull of the vessel. Anyone who stands near the bow or stern of even the largest vessels when the waves are running moderately high, can easily recognize that the hull is an elastic vibrating body, susceptible of movements of considerable amplitude. If the shaft bearings were set on absolutely rigid foundations, the shaft would be subjected only to torsional and compressive forces. Actually, however, these foundations are not rigid, and anyone who has tried to run a line of mill shafting badly lined or supported on weak and settling foundations knows what the result is apt to be.

What the remedy will be for the difficulty can hardly be said. Perhaps special strengthening and stiffening of the part of the hull which carries the engines and shafting may be adopted. One ingenious Englishman has recently proposed to put a sort of universal joint on the shafting between the thrust block and the propeller so that the shaft could "go and come" as it pleased; but the designing of such a joint to transmit such a power and not prove a greater source of danger than that it was intended to obviate, would be a pretty problem in mechanical engineering.

The Manchester Ship Canal.

The engineer who lands at Liverpool, bent on seeing engineering sights will naturally turn first toward Manchester and its ship canal, deservedly ranked as one of the greatest engineering works of modern times. It is only three-quarters of an hour's run from Liverpool to Manchester, and the writer with another American engineer set out upon a pilgrimage thither at once. Surely few more pleasant sights ever greeted a traveler's eye than those which we beheld from our compartment in the train. Dry land is always welcome after one has seen for days nothing but a waste of wafers; and certainly there are few landscapes with so much quiet and picturesque beauty as those of rural England in June. All the pictures with which literature has made us familiar are there before us, the hedges with their load of bloom; the brick walled gardens, with their trim walks and neat borders, sheep and cattle grazing in fields of lush grass, everything over-

flowing with luxuriant life and verdure. Surely the man has no sense of beauty in his soul who can look upon an English landscape on such a bright morning without a glow of [illegible]. As I looked, I thought of another railway [illegible] to another city. Who that has passed through it does not remember those barren, dirty, ragged, refuse-piled and stream-gullied bluffs through which one enters [illegible] from the east. I do not know who is to blame for them, or whether anyone is to blame, or whether [illegible] part of the penalty we have to pay for being a new country with ragged edges; but as I looked I understood [illegible] the first time—how such things must look to the English visitor to America.

But all this is not the Manchester Ship Canal. At the general offices of the canal company in Manchester we were cordially received by Mr. Walter Taylor, Principal Assistant to W. Henry Hunter, Chief Engineer of the canal company, and equipped with passes through his courtesy, we set out on a tour of inspection. The feature of greatest interest in connection with the canal are its terminals. The canal itself is, of course, nothing more than a huge ditch with its banks neatly sloped and smoothed (not left rough and ragged as is the custom with American engineering works). One way to see the canal is to take a launch, or small steamer and go along it; but it is not an agreeable way for its waters are "rank and smell to Heaven." Years ago the writer visited the Bridgeport pumping station in Chicago, where the malodorous liquid in the Chicago River was lifted a few feet and sent on its way toward the Mississippi through the old Illinois & Michigan Canal. The heavy odor which hung about those Bridgeport pumps still lingered in my memory and was brought back most vividly at Manchester. As I stood at the Mode Wheel locks and watched the water seething up from the culverts as the sluices were opened, the same old unmistakable odor appeared.

The fact is that the canal forms a receiving basin for the sewage of the whole Manchester district, or rather all that part of it upon the drainage-basin which furnishes the canal its water supply. Something is done in the way of chemical purification of part of this sewage; but it does nothing more than lessen the amount of deposit in the canal which has to be dredged out.

The dredging plant on the canal, by the way, interested us exceedingly. The problem in dredging here is how to dispose of the spoil. The dredging is done to a large extent in a populous district where land is very valuable, and you cannot find a piece of marsh or waste land to discharge the stuff upon, as in most American dredging work. Two methods are followed for disposal. One is to load up scows which are towed to deep water at the mouth of the Mersey and there discharged, a haul of over 50 miles. The other is to discharge the spoil into large buckets, holding about 4 cu. yds. each, and set in rows on a barge. These barges are towed to a point where some low land can be filled in and the buckets are hoisted by a crane, set on a car, and carried on a light track to a point where they can be dumped.

The dredge used is an endless chain or ladder dredge, the commonest type on this side of the water. Its discharge is, of course, continuous, and is delivered through a chute over the side. The barges have steel hulls and carry on the deck a single row of buckets. These are rectangular in shape and are set as close together as possible. A stick about 2 ins. square is laid along the opening between each two adjacent buckets and prevents the spoil from falling through onto the deck. The buckets are made of heavy steel plate, and fastened to each end near the center of gravity is a cast-iron socket or ear with which the tongs of the crane engage. The bucket is thus easily dumped. The whole plant struck us as an admirable arrangement for dredging work, where the spoil has to be hauled away by rail, and worth copying under similar conditions in the United States.

Whether the ladder dredge is ever likely to become popular with us, is not easy to say. Certainly it can do extremely rapid and economical work when all the conditions are favorable, but I believe it is not suited to such a range of work as our dipper dredge; is more liable to breakdowns and requires a large force of men to run it.

The terminal docks of the canal are located close to the business districts of Manchester, and to an American engineer are a most impressive sight. Briefly described the terminals are a series of broad slips opening off from a widened portion of the canal, and with huge warehouses in the space between the slips. These slips are an excellent example of English engineering of the best class, and its keynote, I may say at once, is masonry. We Americans cannot get out of the habit of using more or less wood, even in our most substantial construction, such as the new docks on the North River at New York; but the British engineer sticks to masonry, first, last and all the time. The slips at Manchester are bordered by walls which look as though they might stand for a thousand years. Huge coping stones finish the wall at the top, heavy enough to stand any sort of blows from ships tying alongside or weights accidentally let fall in hoisting. The snubbing posts are great cast-iron affairs built right into the masonry wall. Along the edge of the slip are two or three parallel lines of track, and on the one nearest the water hydraulic traveling cranes are placed. There is a complete high-pressure water service all along the docks, and when a crane is to work at any spot, it is attached to the nearest hydrant by a pipe with hinged joint, jacked up off its wheels, and is ready for work. Portable steam cranes are also used to some extent, but the hydraulic seems to be the favorite.

The warehouses on the piers seem to combine American and English ideas. They are of steel skeleton construction (about the only place in England where I have seen steel columns used in buildings, by the way). In the outer row of columns, which is more or less exposed to the weather, I saw a wrinkle that greatly impressed me, and I set it down here for the benefit of American engineers. These columns were built up of a pair of laced channels, and the wrinkle to which I want to call attention was that the whole interior of the column was filled solid with concrete. I was impressed with the influence of the concrete in supporting and stiffening the column. Just what its value might be in that direction I cannot say. Perhaps some of our college laboratories looking for new things to investigate might test a pair of such columns, one filled with concrete and the other as ordinarily used. In any event such a steel-and-concrete construction ought to be free frim vibration.

Passing the docks and crossing a swingbridge over the canal (said to be the heaviest in England) my companion and I proceeded to the American grain elevator, built a couple of years ago by Metcalf, of Chicago. It represents (or did when it was built) up-to-date practice in American grain elevator construction (steel circular bins are the latest practice now, I believe). Practically all the machinery in the elevator is American, except the steam engines and boilers which furnish the power. In deference to English ideas (and very sensible ideas too), the outside is covered with brick to protect it against exposure fires, which gives it a more substantial appearance than our American grain elevators.

On the canal proper the most important engineering works are the locks and the swingbridge which carries the Bridgewater canal over the ship canal at an elevation of about 25 ft. The locks are merely very substantial masonry structures of the ordinary pattern, with all the valves operated hydraulically. The Barton Aqueduct, as it is called, is a very heavy center-pier riveted-truss swingbridge, carrying a steel trough which continues the canal prism across the river. To swing the bridge, a gate is shut at the end of the span, another at the end of the canal, leaving only a thin film of water between their faces. A pipe is opened and allows this to escape, and then huge wedges are raised at each side, which, when down, form a water-tight joint. The bridge is then set free and is swung seemingly as easily as if it were not loaded with hundreds of tons of water.

All the machinery is operated hydraulically and its smoothness of working leave nothing to be desired. Less than five minutes are required for the entire operation. I should mention also that half of the weight of the bridge is carried on the center pier by a hydraulic ram, and the load on the turntable is thus much reduced. The bridge is turned by hydraulic power also. A little three-throw water-pressure engine, drives a pinion which engages with the big gear wheel bolted in sections to the center drum of the bridge. A power station on the bank of the river supplies the pressure water to all the hydraulic machinery of this bridge and a highway bridge immediately below it.

One would think that all this hydraulic machinery would cause no end of trouble by freezing up in winter; but the mild English climate is far different from that of "the States," and I was told that there was no trouble at all from this, a little gas burned in the underground chamber where the pressure engines are located, kept them in condition for service at any time. C. W. B.

London, May 31, 1900.

AN INERTIA VALVE PERCUSSIVE TOOL.*

By Chester B. Albree, M. Am. Soc. C. E.†

Recalling the Darlington valveless rock drill and referring to the drawing (Fig. 1), we notice that when the rear edge F of the piston passes exhaust port D, on the back stroke, that a cushion is at once started in the rear, increasing in pressure as the piston travels back. When the front edge A of the piston passes and opens the entrance B of the by-pass B-C initial pressure air flows through admittance port M cylinder cavity and the by-pass to the rear of the piston, immediately checking any further movement and forcing the piston out, by reason of the greater area of surface F over surface A. In such forward movement the edge A again closes the port B of by-pass, cutting off the supply of further initial pressure air to the rear, so that any additional pressure or force upon rear area of the piston must be derived from the expansive action of the air locked in behind it, which, you will notice, is opposed by the initial pressure air bearing on surface A, which is constant at all points of stroke, either forward or back.

It seemed, on study of this device, that if some way could be found to allow air of initial pressure to follow up the piston during its entire downward stroke that much greater piston velocity would be secured.

To accomplish this result it was obvious that an automatically moved valve of some sort must control the flow of air in such a way as to prevent any access to the rear during the back stroke and to permit such access during the forward stroke.

The first solution that appeared was the use of a type of poppet valve (Fig. 2), with a spring bearing upon it, so that when there was no pressure on one side the valve would close under unbalanced pressure, but when the pressure was alike on each side the spring would force it open.

To understand it clearly, referring to the drawing Fig. 2, A is a port admitting air continually against area E; G is a port leading from this area E to the valve chamber shown; C is a valve with spring D bearing against the side of it that is away from the constant supply of initial pressure in port G, arranged so that pressure against it from port G will close it against pressure of spring when no pressure exists back of it; B is a by-pass having two outlets communicating with cylinder h and h'; F is an exhaust port, adapted to be closed and opened by the rear edge of the piston; and J is a guide to prevent the piston from turning, as the device, as shown, required that the valve cavity should not come in contact with the exhaust port F.

In action air enters through A, pressing against small area E, closes valve G and forces the piston back, the space in the rear of piston and in the by-pass and valve cavity having exhausted through port F.

When the piston travels so that the edge E passes port B air at high pressure goes through by-pass to rear, and at the same time through the port h into the valve cavity, thus equalizing the pressure on the sides of valve C, which opens under the pressure of the spring D, permitting free passage of the air through port E and the valve cavity port h and by-pass to the rear, forcing the piston out, owing to the excess area.

As it travels out, this passage, either through B or h, is continually open, so that a continuous current of air flows through the valve at initial pressure until the exhaust port is opened at F, reducing the pressure in the rear, when the valve again closes and the action is repeated as described.

This seemed very nice on paper and worked fair to middling badly. When the spring C was exactly right in intensity for a given air pressure it worked nicely, but any variation of pressure interfered with good results. Again, the rush of air through the valve had a strong tendency to close it, requiring a superfine adjustment of the intensity of the spring. For static pressures the idea was all right, but for dynamic pressures, if one could so call air under pressure in motion, it was not all that could have been desired.

In the line of simplicity and experiment a rearrangement of the parts was made, as shown in Fig. 3. The poppet valve was placed in the axis of the piston, which did not then require guides to keep it from turning, and the construction was simpler. Results somewhat better than in the first machine were attained, but it was discovered that the inertia of the poppet valve interfered with the contemplated action of the device.

This movement of the valve by inertia suggested the use of a form of slide valve that should be controlled entirely by inertia, opening and closing suitable ports in its travel to accomplish the desired ends. A tool, as shown in the drawing (Fig. 4) was designed, having an axial hole in the center, within which a small tube could move freely within fixed limits.

A constant supply of air is admitted at 4 against the small area of piston. Ports 5-5 lead from a point adjacent to this small area into valve chamber, which in turn opens to the rear end of piston.

An exhaust port, 14, leads through the cylinder and a groove around exterior of piston communicates by a port, 7, to the valve chamber. In starting the tubular valve is at the outer end of chamber, thus closing ports 5-5 and leaving ports 7-7 open.

Owing to the constant pressure on the small area and the exhaustion of pressure in rear of piston, it travels back and the rear edge closes exhaust port 14, which, however, registers at the same instant with annular groove on the piston, establishing a new means of exhaust through the valve chamber, ports 7-7, and annular groove 8 to port 14. This passage remains open until the groove 8 passes exhaust port 14, and the piston cuts off further exhaust. A cushion then commences, which tends to check the velocity attained by the piston, but not that of the valve carried thereby, and traveling with equal velocity. Being free to move, the valve slides back until it meets stop 9.

In this position the interior exhaust ports 7-7 are closed and the admittance ports 5-5 are opened, and initial pressure air flows through the valve to the space in rear, driving piston out by reason of the excess area.

The valve remains in this back position, allowing air to flow through it until the piston has struck its blow, when the valve slides, by reason of its inertia, to its outer position, and the action repeats as described.

It will be noticed that full pressure is exerted until after the piston has struck, and also that the valve will shift at

*Condensed from a paper read before the Engineers' Society of Western Pennsylvania on May 15, 1900.

†14 Market St., Allegheny, Pa.

any point during the out stroke if the piston is stopped, provided that exhaust can occur. The possible limit of practicable variation of stroke is thus only limited by the distance found necessary to use for a rear cushion to prevent piston from ever striking the back cylinder head. This varies from one-quarter to one-third of the stroke length, thus permitting a wonderful variability.

The tool, as described, worked very well at times, but it was discovered that the valve had a strong tendency to bounce back, especially on the front stroke. This unlooked for movement of the valve had very disastrous effects, as may be imagined, causing the action to be extremely erratic.

To obviate this trouble brakes were applied to the valve

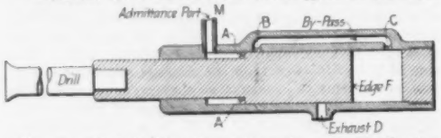


Fig. 1.—Sketch Showing Operation of Darlington Valveless Drill.

to prevent its sliding so easily. The machine ran well when it got a good start, but the valve was liable to stick at the wrong end of the chamber, and there was great difficulty in starting again until the piston had been jarred by hand, so as to bring the valve where it should have been.

Other expedients, such as the use of rubber, lead, wood and other buffers supposed to be inelastic were tried in the endeavor to stop the bounce with but little success, as anything soft enough to prevent bouncing was soon hammered out of all shape, the pieces clogging up the valve chamber. All sorts of shifts, profoundly wise and exceedingly foolish, met the same fate, until we were almost disheartened and disgusted with the perversity of things inanimate. In pondering over the failure the idea of counter-balancing the rebound of the valve by a smaller mass colliding with it at the instant rebound commenced arose.

A little model device to test recoil neutralization (Fig. 5), consisting of a pipe with two collars fastened to it, having between them another piece of pipe large enough to slip freely on the outside of the other and a little less in length than the distance between the collars, was made.

On holding this device about three or four feet above a block of steel, with the outer tube, or "rider," as it was named, bearing against the upper collar, it was dropped vertically. The lower end of the inner tube struck first and started to rebound, but the rider, traveling at the velocity due to the fall, slipped over the main tube until it struck the lower collar, fast on inner tube, thereby checking the upward velocity of the rebounding inner tube, so that the combination practically did not rise perceptibly from the steel block, landing almost as dead as a chunk of putty.

It seemed as if this principle could be applied to the valve so as to overcome its rebound and at the same time give the freedom of motion necessary to good action. A modification of the valve was made with a rider attachment, which, when tried, caused the tool to work with the regularity of clock work.

In designing the valve and rider a study was made of the coefficients of rebound of various materials, and it was found that a great deal of difference in results and theory existed among the acknowledged authorities on applied mechanics, authors of distinction, such as Rankine, Weisbach and others, giving tables with wide variations for similar materials.

In order to be sure recourse was had to experiment with different materials to determine what proportionate weights the valve and rider should have to each other.

It has been demonstrated by mathematicians that the modulus of elasticity of rebound is equal to the ratio of the velocities of the relative bodies after and before impact.

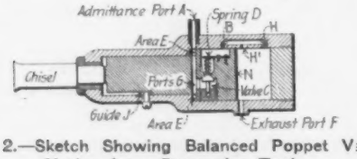


Fig. 2.—Sketch Showing Balanced Poppet Valve Motion for a Percussion Tool.

If a body suspended from a small cord from a fixed point be made to oscillate like a pendulum it will acquire a velocity at its lowest point proportional to the chord of the arc through which it has swung, and if the arcs are not very long the times of descent will be equal for different length arcs; hence, if the suspended body strikes a stationary body when at its lowest point and the angular distance through which it rebounds be noted, the ratio of the original to the return velocity can be determined.

It was found that for steel striking steel it was as 100 to 60, and for steel striking vulcanized rubber backed by steel about 100 to 37. The fiber was used, as it stands the pounding of the valve without itself disintegrating or upsetting end of valve.

Knowing, then, the modulus of recoil, we can figure the velocity a body will acquire at the instant after collision on the rebound if we know the velocity with which it struck.

If, in addition, we know the weight of the striking mass we can find the energy of momentum at that instant and have only to make the weight of rider such that its momentum due to the initial velocity shall be equal to that of the valve rebounding, practically to eliminate the return movement of the valve. When two perfectly elastic bodies meet each rebounds with substantially the same velocity with which they met, but with imperfectly elastic bodies of unequal masses and velocities the rebound depends on which has the greater weight and velocity; hence we can approximately calculate the weight of rider so that the valve will stop short and any rebound will occur in the rider only. This rebound can be made so little that it does not influence the valve itself and the desired result is attained.

In making these investigations certain interesting points came up that are worthy of further study to understand fully the reasons for them.

The recoil certainly depends upon the elasticity of the colliding bodies, yet the ratios found by experiment seem to bear no recognizable relation to the established coefficients of elasticity given in text books on the strength of materials. Evidently the amount of energy in the moving masses and the area of contact influence the result. If the striking area is small the entire energy, converted into work, is exerted on a small unit of surface, causing a strain per unit area greater than the materials would stand. In this case the limit of elasticity, as ordinarily understood, might be exceeded, when the work would be expended on tearing or crushing the material instead of causing rebound.

On the other hand, if a body of equal weight and velocity to the one described, but having a much larger striking area, were to collide it might easily be conceived that the strain per unit of striking area would be less than the limit of elasticity of the materials, and that practically most of such energy would be consumed in bending or squeezing the materials, which would spring back to their original position and in so doing force the colliding body back into space with a velocity dependent upon the strain produced and the coefficients of elasticity of the bodies.

To elucidate the truth of this hypothesis would require

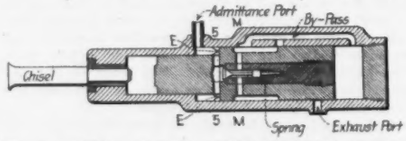


Fig. 3.—Sketch Showing Axiel Poppet Valve for a Percussion Tool.

a great deal of careful experiment and research, and would be suitable work for some mechanical laboratory connected with a technical school. Accurate information on the subject would be of great value. It might originate a new method of testing materials, although somewhat analogous to impact testing that is now in vogue, although the results in the latter system are derived from measurements of bends made transversely in the specimens struck. By this method such results would probably be derived from a comparison with the velocities of rebound from standard substances of bodies of given form and with given velocity.

The latest model of a direct-acting chipping tool is shown in the accompanying sketch (Fig. 6). You will note that the valve will move at any point of the stroke if the velocity of piston be checked, and that within the limits for cushion described earlier in this paper the stroke is variable.

While this variability of stroke is not so essential in a chipping hammer or any tool of the second class of percussion where an interposed tool receives the blow, yet for machines of the first class, such as rock drills, steam hammers, gold mine stamps, etc., such variability is desirable and essential to attain the best results.

In this hammer the exhaust takes place at very nearly the initial pressure; hence a great deal of energy contained in the compressed air is wasted, although the piston velocity on the down stroke is great, giving a powerful blow.

It seemed as if some of this waste might be obviated by working the air compound, using a different form of inertia valve, so as to retain the good features of the device.

It was evident that a constant supply of initial pressure air should be furnished, available at any point of the stroke, but that it should have access to one end of the piston at certain specified times only, and that the valve should permit of opening a passage from this side of piston to the other, which necessarily should be of larger area to allow of the locked in charge of high pressure air acting expansively on both piston areas.

It was also a condition that during the movement of the piston under initial pressure that the other end of the cylinder should be open to exhaust in such a way that a certain amount of variability of stroke would result and sufficient cushion formed to prevent p[iston] striking cylinder head.

These conditions were fulfilled in a machi[ne] of the type shown in the illustration. An annular [groove] was provided on a portion of the exterior [of] the piston that was in register at all points of the stro[ke] with an admission port of high pressure air. An axial [hole] was provided, open at the rear end, in the [bo]dy of the piston, having from it ports leading to the co[nstant] supply of motive fluid, other ports leading to a poi[nt] adjacent to the small diameter of the piston and exha[ust] ports arranged so that exhaustion could occur throu[gh] them dur-

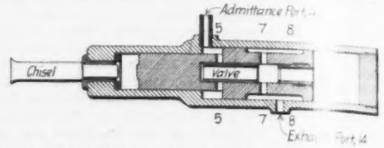


Fig. 4.—Sketch Showing Operation of Direct-Acting Inertia Valve Hammer.

ing the greater part of the back stroke, but [is] closed by the motion of the piston for the remainder of [the] stroke.

A tubular valve was placed in this central chamber, having on its exterior surface an annular groove, so placed that when the valve was at the outer end of its travel it would register with the ports from the constant source of supply and the ports leading to smaller piston area, while at the same time a port through it would permit of exhaustion.

In action the pressure against the small area of piston drives it back, air in the rear meanwhile having a free vent through the exhaust ports until piston in its travel cuts off exterior exhaust port, thus cushioning the air remaining back of piston and checking velocity of piston when the valves moves by its inertia to the rear end of its travel.

In this back position the supply of high pressure air is cut off, as is also the exhaust port, and a port in the valve itself registers with the port leading to small piston area, permitting the air locked in in front of piston, now at back position, free passage to the rear. The pressure immediately tends to equalize on both ends of piston, and owing to the larger area in the rear the piston is forced out under the force of the expanding air from the front end of cylinder, continually decreasing in pressure as the piston moves and the volume or space increases. The piston striking causes the valve to shift back to its original position and the action continues.

It is obvious that if the piston were back when at rest that there would be no locked up air to expand, so that it could not start, and to overcome this difficulty a spring is placed back of the piston, just strong enough to force it out when no air is admitted. No loss of power results, as the energy stored up in it on the back stroke is given out on the front stroke and it serves to help cushion.

The valve also is provided with a light spring sufficient to keep it in the outer end of its travel when the piston is at rest, so that all will be in readiness to start on opening throttle valve. The inertia of the valve on the down stroke is sufficient when piston is constantly accelerating in velocity to prevent this spring closing the valve prematurely.

The proportion of expansion can be determined if the clearances are known for any ratio of piston area. It has been found that for air the proportion of 10 to 3 is good, as this gives a terminal exhaust pressure of about 12 lbs. per sq. in. if 80 lbs. were the initial pressure. This permits of prompt exhaustion, and no vacuum is formed in the rear, as would be the case if greater ratio of expansion were adopted. Such a ratio could be used with steam, as a condenser might be attached, but no experiments have been made in that line.

With this tool about three times as much work can be done with the same volume of air as with a direct-acting tool, exhausting at initial pressure, or the same work can

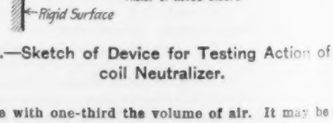


Fig. 5.—Sketch of Device for Testing Action of Recoil Neutralizer.

be done with one-third the volume of air. It may be seen that the diameters of the tool might have to be larger to effect these results and that the mass of piston would be larger in consequence. In practice a longer stroke has been adopted, in order to avoid the back kick due to large diameters, as explained earlier. The length of stroke does not effect the ratio of expansion, as the volumes in front and rear of piston change in definite proportion.

The velocities attained in forward and back strokes in either the compound or single-acting hammers can be calculated with fair accuracy when the diameters, piston areas, pressure per square inch, length of stroke and weight of piston are known, as these are constants or

known variables. The amount of friction, leakage and loss due to reversing inertia are difficult to determine exactly.

Knowing the velocities and the volumes of motive fluid used, the number of strokes per minute and the amount of air consumption can be closely approximated, and in practice [illegible] of the number of strokes and accurate measurement of air consumption by meter check out within from 5 to 10% of the theoretical results figured.

Thus a tool can be intelligently designed to do the work expected of it as regards force of blow, frequency of stroke and air consumption at any given pressure.

This valve motion would seem to be applicable to a great variety of purposes, even to running a compound engine with telescopic economy. The power of the stroke due to

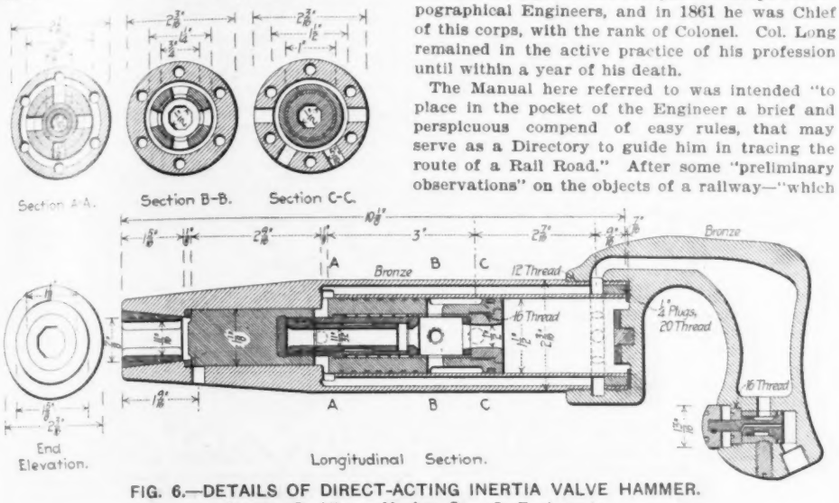


FIG. 6.—DETAILS OF DIRECT-ACTING INERTIA VALVE HAMMER.
Chester B. Albree, M. Am. Soc. C. E., Inventor.

expansion is not 5% less than that due to initial pressure, and a machine can be designed to strike by either initial pressure or expansive pressure, as desired. The latter has been chosen as giving simpler construction in the tool.

The valve motion described and the anti-bouncer arrangement are covered by several patents, as is the poppet valve tool described. The tools, as now made, run very satisfactory on long and severe tests, and are practicable and useful. Endurance tests of materials and detail parts are now being made with the view of discovering all weak points. When these have resulted satisfactorily the tools will be put on the market.

Owing to the great number of strokes and the small cylinder volumes in the tools already experimented with, it has been impossible to make indicator tests, so a study of the action of tools was only possible by observation of action, air consumption and number of strokes per minute, as the valve itself could not be seen at work. It followed that by induction only could one arrive at the causes of some of the erratic performances and failures of the tools.

THE FIRST AMERICAN RAILWAY ENGINEERS' MANUAL.

As an outcome of our late notes upon early American engineers' field books, we are indebted to the courtesy of Mr. John F. Ward, M. Am. Soc. C. E., for the privilege of examining what is claimed to be the first manual published in the United States for the use of railway engineers. Its full title is as follows: "Rail Road Manual, or a Brief Exposition of Principles and Deductions Applicable in Tracing the Route of a Rail Road. By S. H. Long, Bt. Lt. Col., Engineer in the service of the Baltimore and Ohio Rail Road Company. In two parts. Baltimore, Wm. Wooddy, printer. 1829." This book is strongly bound; is 5½ × 3½ ins. in size, and contains 109 and 62 pages. The Manual is dedicated to the President and Directors of the railway company named; and the author mentions that it embraces "Document I., referred to in the first annual report of your board of Engineers."

The author, Stephen Harriman Long, is well known as an early American engineer. He was born in Hopkinton, N. H., on Dec. 30, 1784, and died at Alton, Ill., Sept. 4, 1864. After graduating at Dartmouth College, he entered the United States Army in 1814, as a lieutenant in the corps of engineers, and was Assistant Professor of Mathematics at West Point until 1816. Between 1818 and 1823 he was in charge of an expedition sent out by the government to explore the country between the Mississippi River and the Rocky Mountains, and Long's Peak in the latter range was named after him; he also explored the sources of the Mississippi River. From 1827 to 1830 he was the engineer in chief of the Baltimore & Ohio R. R., and in 1837-40 he held a similar position on the Western & Atlantic Ry. in Georgia. It was while in the service of these railways that he invented the Long bridge truss, which came into quite extensive use in the United States. This truss was fastened together by wooden trenails, no iron connections being used. In 1838 Mr. Long was made Major in the reorganized Corps of Topographical Engineers, and in 1861 he was Chief of this corps, with the rank of Colonel. Col. Long remained in the active practice of his profession until within a year of his death.

The Manual here referred to was intended "to place in the pocket of the Engineer a brief and perspicuous compend of easy rules, that may serve as a Directory to guide him in tracing the route of a Rail Road." After some "preliminary observations" on the objects of a railway—"which are chiefly to subserve the purposes of reciprocal trade"—the author discusses "geometrical principles and their illustration," and then proceeds to give rules for tracing various curves upon the ground, both circular and elipsoidal.

Chapter V. is devoted to the instruments employed, and is especially worthy of note as showing the outfit of the early engineer and for the use of terms unknown to the present generation. The list of instruments includes—"A leveling instrument and tripod stand, with appropriate adjustments; a compass, circumferentor, or plane table graduated to half-degrees; two vane-staves and targets, carefully graduated into feet, tenths and hundredths; a chain of 50 ft., composed of links a foot long, together with 10 or 11 chain-pins." Col. Long notes that the chain "for tracing the guide-line" may be 100 ft. long—with 1 foot links; but he thinks that the long chain is better adapted to the measurement of "secondary chords."

Among other tools named as requisite is a "Centessimal Scale," 4 ft. long, graduated in the same manner as the "vane-staves" and furnished with "a movable index fitted for the reception of one of the Pickets by which the sub-chords are designated." This scale is to have a hook at one end which may be inserted in the mid-ring of the chain; and it was evidently intended to be used in measuring the versed-sine and locating stakes on the curve. The engineer was also to be equipped with a "pocket-sextant, theodolite, repeating circle, or other gonyometer of accurate adjustment." He says that the engineers of the B. & O. R. R. Co. had adopted as more convenient than others a scale of 8 ins. to one mile, graduated to units of 10 chains each, and by means of decimal diagonals, to chains and tenths of chains, or sub-divisions of 5 links each. On the reverse side of this scale was another of 2 ins. to 100 ft., divided by decimal diagonals to divisions of 5 ft. or links each.

The "mode of executing the surveys and demarkations for a railroad" gives us some interesting directions, intended to avoid mistakes in the results. "The engineer at the instrument directs the vaneman, by waving his hand, or by oral exclamation, to raise or lower the target, till the cross upon it is in exact coincidence with the axis of the telescope. The vaneman should then take down the vane-staff and screw the target fast to the staff, etc." The "vaneman" is told to cry out the elevation if nearby, and if too far away to be heard he must advance within hearing and, "audibly and distinctly, proclaim the observed altitude" without again looking at the scale. He must finally present the target to the engineer for his inspection, and if it does not agree with the "proclaimed altitude" the observation must be repeated. For a "definitive location" the distance between stakes was limited to two chains, or 100 ft.; and on the stakes the number of the station and the cut or fill were marked, as at present.

Col. Long, in briefly describing "Bolting-tracks, or Turn-outs," says that the two appendages of a double-railroad are: "Sidelings and centrelings." The former consists of two tracks, "placed exteriorly of the road," and the latter "of a single track located between the main tracks of the road." "Each track of the sidelings should communicate with the adjacent track of the main road at both ends, while the centrelings has at each end a communication with and serves as a receptacle for the carriages of both tracks." The sidelings are to be used at depots and main stations, while the centrelings are utilized as "mere stopping or resting places"—for the horses probably—and should be one mile apart.

While this description is a little involved, the author evidently refers to a double-track railway and to a period antedating frogs, as he nowhere refers to the latter. The sidelings are really side-tracks, one outside of each main track, and each connecting with the main line at either end. At the point where one rail crossed another the rails were simply cut out for the passage of the flange of the wheel. Where the centreling was used the main tracks were apparently spread apart sufficiently to place a third track between them; this centre track was connected at the ends to the two main tracks, making a cross-over. It was not necessary to connect the centre track to both main tracks at both ends, though such a connection would have saved some backing in shifting trains.

A supplemental chapter discusses the elevation of the outer rail on curves, and a table is given for this elevation in inches at different speeds up to 20 miles per hour, though 5½ ins. difference in elevation on a 14° curve at the maximum speed would be considered excessive by a modern tracklayer. The tables given include one of deflection angles, chords and vered sines for various radii; roots and squares; superelevation of rail and a table of ordinates. Elaborate comparisons are made by Col. Long between the efficiency of animals and steam power on railways, and he carefully discusses the adhesion of the wheels to the rails, in the latter quoting from "Wood on Railroads."

In the Manual, Col. Long refers to the wooden bridge truss patented by him in 1830. He notifies the public that he has recently devised a mode of constructing wooden bridges for railways and turnpikes, and that he intends to apply for a patent. He had a model constructed in wood, 6 ft. long, 2 ft. wide and 18 ins. high; the transverse floor beams were 6 ins. apart, and were substantially braced so as to form "an unyielding support" for a double system of railway tracks. The connections were made by "lock-joinings without a single mortice or tenon." This model contained 16 ft. B. M. of white pine and 69 screw-bolts 1¼ ins. long by ⅛-in. diameter, and it weighed 36 lbs.; it sustained a center load of 3,000 lbs. Col. Long estimates that for a "railed bridge" 72 ft. long and 24 ft. wide, including rails and flooring, there would be required 30,000 ft. B. M. of timber and 250 lbs. of screw-bolts; this does not include the spikes and nails.

THE SPUYTEN DUYVIL SWING BRIDGE; NEW YORK CENTRAL & HUDSON RIVER R. R.

(With two-page plate.)

We illustrate in the accompanying cuts and on our two-page plate this week the principal details of the 290¾-ft. swing bridge built in 1899 to carry the double track of the New York Central & Hudson River R. R., over Spuyten Duyvil Creek, where it empties into the Hudson River at the ex-

treme northern end of Manhattan Island. While this bridge is not of remarkable size, it is of considerable interest to engineers, as representing the latest standards of the railway named in bridge design and detailing, and, also, for the manner in which the designer has handled the very shallow turntable construction which the local conditions necessitated. Several of the details of the fender pier and foundation construction, which are illustrated, will also, we think, be of interest to many of our readers. The design was worked out by Mr. Robert Giles, M. Am. Soc. C. E., late Assistant Engineer, under the direction of Mr. W. J. Wilgus, M. Am. Soc. C. E., Chief Engineer, and according to the standard specifications of the New York Central & Hudson River R. R. We are indebted to these two gentlemen for the information from which the following description of the work has been prepared.

Fig. 1 shows a general plan of the bridge site and a diagram sectional elevation of the structure itself. As will be noticed, the bridge crosses Spuyten Duyvil Creek close to its junction with the Hudson River, where the width between bulkhead lines is very nearly 613 ft. The borings showed at this point a deep layer of silt overlying a layer of fine sand, which rested on a bed of rock and boulders. Pile and grillage foundations carrying masonry piers were adopted. From the records of pile driving kept while building the temporary trestle parallel to and close alongside the new bridge, the penetration of the piles at the points designated on the plan in Fig. 1, when using a 3,900-lb. hammer falling 10 ft., was as follows:

Location.	Below datum.	Last blow.
A	— 81.0 ft.	1½ ins.
B	— 81.0 "	4 "
C	— 58.4 "	Refused.
D	— 44.7 "	"
E	— 36.8 "	"

As a matter of fact the piles in the bridge foundations proper were driven in each case well into the bed of sand, as shown by the sectional elevation.

Referring to Fig. 1, it will be seen that the same form of construction was employed throughout the substructure. This construction is shown in detail for the pivot pier by Fig. 2, and it was the same except for dimensions in all the other piers. A pit was first dredged into the layer of silt for each pier, and in this pit was driven the cluster

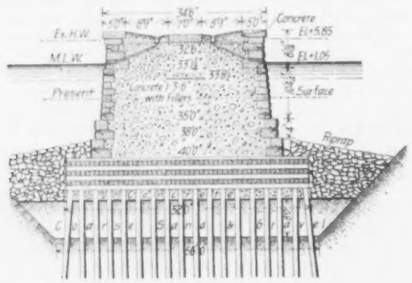


Fig. 2.—Plan and Vertical Section of Pivot Pier; Spuyten Duyvil Bridge.

of piles for the pier. The pit excavation for piers I., II., and III., Fig. 1, was about 20 ft. deep, and for pier IV. it was about 13 ft. deep. After the piles were driven, gravel and coarse sand was filled into the bottoms of the pits, and around the piles to a depth of 8 ft. for piers I., II. and III., and to a depth of 6 ft. for pier IV. On top of this gravel was placed a 2-ft. layer of concrete coming up flush with the tops of the piles when they were sawed off. The grillages rested on the top of this concrete. The grillage for the pivot pier II. was 5 ft. 6 ins. thick, and for the other piers it was 4 ft. 6 ins. thick. The pier masonry consisted of a cut-stone facing and coping backed with one cement, three sand and six broken stone concrete, with large stone fillers. The grillage and lower masonry of each pier was protected by riprapping, which nearly filled the pit.

The design and composition of the members and connections of the swing span are fully shown by the drawings of Fig. 3, but attention may be directed particularly to the riveted connections which represent the present standard practice of the New York Central & Hudson River R. R.

As already stated, the turntable construction is of somewhat special interest because of the limited depth occupied. This construction is quite clearly shown by Fig. 4, and is further explained by the general diagram plan of Fig. 5. Fig. 6 is particularly interesting for showing the assumed

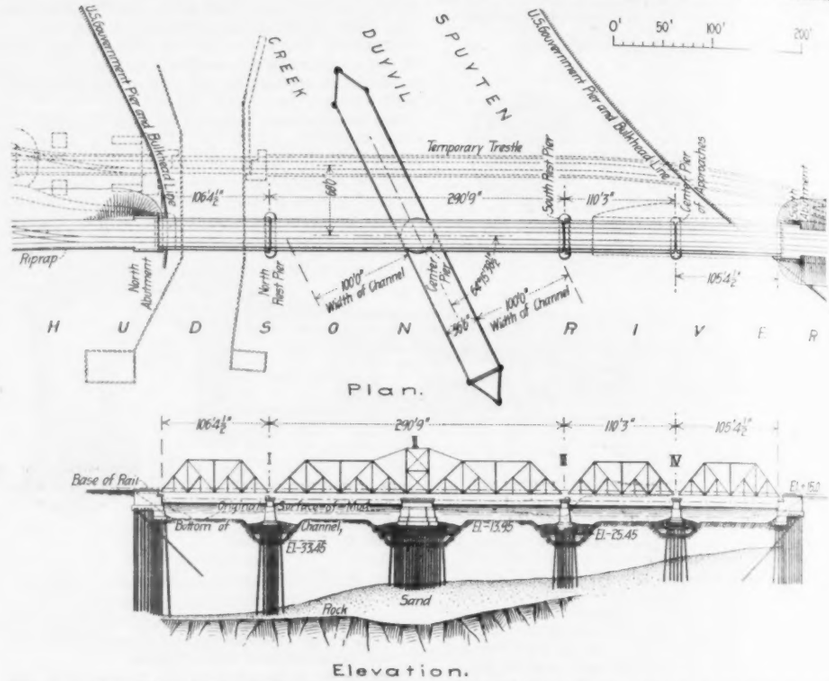


FIG. 1.—GENERAL PLAN AND PROFILE OF SPUYTEN DUYVIL BRIDGE, N. Y. C. & H. R. R. R.

Turning now to the superstructure, it will be seen from Fig. 1 to consist of three fixed spans and a swing span having an aggregate length of 613 ft. 1 in. c. to c. of end piers. Details of the swing span only are shown by the drawings, since the connections, floor system, and truss design are of the same general character in this and in the fixed spans. Fig. 3 shows sectional top and bottom plans, and a side elevation of one-half of the swing span. This span is the familiar center tower and suspended truss pattern commonly employed for railway swing bridges in America. It was calculated: (1) for the dead load with the span open; (2) for the dead load, span closed partly continuous over four supports; (3) live load as fixed span; (4) live load, both arms loaded, partly continuous over four supports; (5) live load, one arm loaded, advancing on the other arm, partly continuous over four supports. The loads employed in the calculations were as follows: Dead load, 2,300 lbs. per lineal foot of truss; live load, 5,000 lbs. per lineal foot of truss plus an excess of 50,000 lbs. for web members. Wind load, top chord, 225 lbs. per lineal foot of truss, and bottom chord dead, 300 lbs. per lineal foot of truss, and bottom chord live, 450 lbs. per lineal foot of truss. The unit stresses allowed with this loading were: Tension live load, 8,000 lbs. per square inch of net section; tension dead load, 16,000 lbs. per square inch of net section; shear, 6,000 lbs. per square inch, reduced 20% for field rivets; bearing, 120,000 lbs. per square inch, reduced 20% for field rivets; compression, live load,

$$\frac{8{,}000}{1 + \frac{L^2}{18{,}000\ r^2}},$$

dead load,

$$\frac{16{,}000}{1 + \frac{L^2}{18{,}000\ r^2}},$$

loading for each principal member of the drum, with the strains which result and the composition adopted to withstand them. In material and workmanship the turntable and all other parts of the superstructure were required to conform to the standard specifications of the railway company for steel bridges.

One part of the structure which has been worked out with unusual attention to details is the draw rest. Its construction is fully shown by Figs. 7 to 12, inclusive. Fig. 7 shows a general plan and several sections of the east half of the draw rest. The west half of the rest differs from the east half only in the construction of the wedge-shaped end, as shown by Fig. 8. Figs. 9, 10 and 11 show enlarged details of the framing at various points in the structure. The construction of the draw rest and fenders around the center pier is shown by Fig. 12. In all of these drawings the details are so plainly drawn and labeled that further description is unnecessary.

TECHNICAL EDUCATION IN IRON FOUNDING.

At the annual convention of the American Foundrymen's Association, held in Chicago last week, a resolution was adopted to urge institutions of learning to provide courses of education in the principles and practice of iron founding, so as to provide a high grade of men for such positions as foremen and superintendents of foundries. Two interesting papers on education of this kind were presented, and are abstracted below. The first one, by Mr. Kirk, recommended that chemists be put in entire charge of the foundry work. The second one, by Mr. West, advocated the much broader and more liberal plan of technical education for men in the positions of foremen and superintendents. This second paper was the more favorably received of the two.

The Training of Foundry Chemists.

By Dr. Edward Kirk.*

There is not an institution of learning in this country that gives a practical course in foundry iron chemistry or foundry chemistry. While the employment of chemists in foundry practice has been strongly advocated for a number of years by the various foundrymen's associations and leading foundries, they have failed to take any steps to provide chemists educated for this work. At the present time, it is impossible to obtain from the graduating class of any of our colleges or schools a single chemist capable of doing anything as a foundry chemist, save making analysis of irons. Not only are there no schools for the proper training of foundry chemists, but there are practically none for the teaching of foundry practice.

To prepare a student to become a chemist in foundry iron, he should be given a practical course in analysis of coke, coal, iron, and the mixing of irons from analysis that will enable him to produce from his analysis an iron at the cupola spout having any degree of hardness, softness and strength required in the various grades of work to be cast. He should be given a practical course in cupola management in every detail, from the chipping out of a

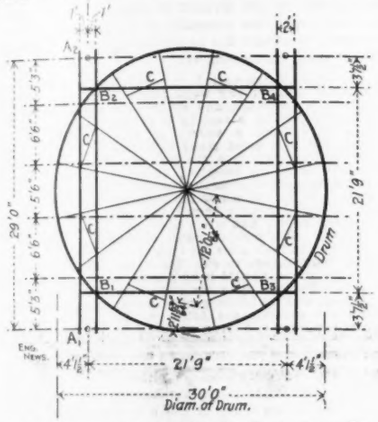


Fig. 5.—Diagram Plan of Turntable; Spuyten Duyvil Bridge.

cupola to dropping of the bottom. He should also be given a practical course in analysis of coal, coke, iron fire-brick, clay, loams, sands, facing, and all materials employed in foundries.

When employed at a foundry, he should be competent to not only manage a cupola and produce irons suitable for the various grades of castings, but also to determine by analysis whether a sand is a good molding sand or not; if sands are suitable for heavy or light castings; if a facing or blacking will peel the sand from heavy or light work and give a smooth surface.

With a chemist properly trained as a foundry chemist, foundry practice, in my opinion, can be revolutionized and a much higher grade of castings produced at a less cost than at the present time.

Under the present system of foundry chemistry, as advocated by some of our leading founders and practiced in some foundries, the chemist is only required to make analyses for the founder or foreman from which to make mixtures of iron, and the chemist is only responsible for the accuracy of his determinations. That this system does not give satisfactory results is clearly indicated by the small number of foundries employing chemists and failure to improve the quality of foundry iron under this system. The chemist should not only be given charge of the laboratory, but should be given full charge of the cupola, the mixing and melting of irons, and be held responsible for the quality of iron at the spout. This is the practice in every foundry in which chemistry has been a real success.

At one of the largest and best known foundries in this country, at which a chemist has been employed for many years, the chemist has full charge of the laboratory, cupola and iron, and is not only responsible for iron at the spout, but has been under a written guarantee for years to produce iron at the spout having the density, hardness, softness, strength, etc., called for in specifications for government and other engineering work. At this foundry, castings are made in the same heat weighing from a few ounces to many tons, for all of which a suitable iron must be provided. That a properly educated chemist can produce such irons at the spout has been clearly demonstrated at this works.

The silicon basis system in foundry irons has enabled the founder to produce castings with a little more certainty as to the degree of hardness and softness than by the fracture system.† Beyond this it has been of no advantage to the founder, and to the foundry industry it has been a decided disadvantage. Silicon reduces the strength of cast iron, and the greater certainty in the degree of hardness and softness in castings is at the expense of the quality of iron.

Since the introduction of this system, it has been the aim of almost every furnaceman making foundry iron to increase the per cent of silicon in his iron. And silicon has been increased to so great an extent that the quality of foundry iron has been greatly reduced; and the practical founder is no longer working for high silicon irons, but for an iron low in silicon or free from it, that his casting may have strength and other desirable properties that are destroyed by silicon in cast iron. What the founder wants, to hold his own against steel, is a foundry iron having all the characteristics of the hot and cold blast charcoal foundry irons of forty years ago. That such an iron cannot be produced by the silicon basis system is a well known fact to every practical iron chemist, and the sooner it is discarded and the true basis for the manufacture and mixing of foundry irons sought for, the better it will be for the foundry industry.

*Philadelphia, Pa.

†This statement as to the alleged certainty of grading pig iron by fracture was very strongly denied in the discussion, as were also the statements as to the objectionable features of silicon.—Ed.

Training Students in the Principles of Scientific and Commercial Founding.

By Thos. D. West.*

For some eight years or more attention has been called by writers to the desirability of colleges training students in the art of founding. A few colleges have fitted up departments for such training, and, in some instances, have adopted the writer's books to assist them in imparting instruction. Mention is made of this fact at the start merely to show that there is a want, and that some colleges are making an effort to fill it.

Recent discussion on this subject might lead to the conclusion that I am opposed to colleges giving instruction in founding. This is due to my objections to educating chemists to the assumption of entire responsibility for results in mixing and melting of iron for general founding, as recently advocated by Dr. Kirk and others. I do not limit the chemist or any student to an understanding of the principles of cupola work only. If the chemist is taken out of his laboratory to assume any responsibility for results of mixtures or melting, he should also be competent to assume responsibility for molding, as dividing responsibility of the mixing and melting from the molding can only cause contention. This is exemplified in nearly every instance in which the chemist has been led by proprietors to take charge of mixing metals or the cupola work on account of assumed inability of foundry foreman. I would not place any obstacles in the way of the chemist learning all he can about the mixing of metals and cupola work, etc. On the contrary, I would have him extend his knowledge in these lines all that is possible, as this cannot but make him more profitable to his employers as a chemist.

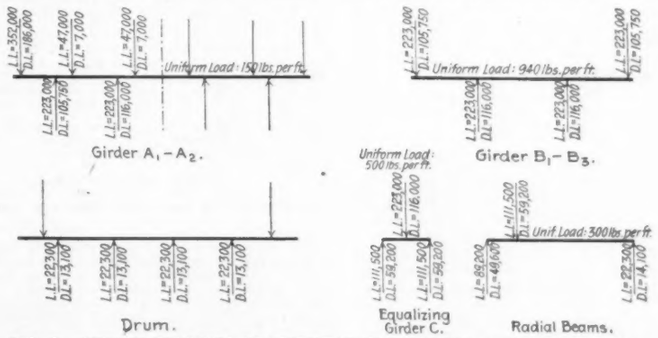


FIG. 6.—STRAIN DIAGRAM OF TURNTABLE MEMBERS; SPUYTEN DUYVIL BRIDGE.

Girder A1-A2.—Maximum bending moment: live load, 2,322,000 ft. lbs.; dead load, 1,294,000 ft. lbs. Maximum shear: live load, 352,000 lbs.; dead load, 191,400 lbs. Composition: web, two 37 × ⅜-in. web plates, four 20¾ × 1-in. side plates, 6 ft. 8 ins. long, each end; flange, four 8 × 8 × 1-in. angles, four 18 × ⅝-in. cover plates, two 18 × 11-16-in. cover plates.

Equalizing Girder C.—Maximum bending moment; live load, 261,000 ft. lbs.; dead load, 139,000 ft. lbs. Maximum shear: live load, 111,500 lbs.; dead load, 59,200 lbs. Composition: web, two plates ⅜-in. thick, 20⅛ ins. deep at ends, two side plates ⅝-in. thick; flange, two 8 × 8 × ⅝-in. angles, one 18 × ⅝-in. cover plate.

Drum.—Maximum bending moment: live load, 67,800 ft. lbs.; dead load, 39,700 ft. lbs. Maximum shear in web plate: live load, 57,000 lbs.; dead load, 30,000 lbs. Composition: web, one 24 × ⅜-in plate; flanges, two 6 × 4 × ¼-in. angles.

Girder B1-B3.—Maximum bending moment: live load, 1,422,000 ft. lbs.; dead load, 694,000 ft. lbs. Maximum shear: live load, 223,000 lbs.; dead load, 111,700 lbs. Composition: web, one 35 × 15-16-in. web plate, two 18½ × 1-in. side plates, 6 ft. long, each end; flanges, two 8 × 8 × 1-in. angles, one 18 × 13-16-in. cover plate, three 18 × ¾-in. cover plates.

Radial Beams.—Maximum bending moment: live load, 267,600 ft. lbs.; dead load, 149,000 ft. lbs. Shear at drum: live load, 89,200 lbs; dead load, 49,600 lbs. Shear at center: live load, 22,300 lbs.; dead load, 14,100 lbs. Composition: web, one 21⅜ × 11-16-in. web plate, two 9¾ × ¾-in. side plates, 4 ft. 2 ins. long at drum; flange, two 6 × 6 × ¾-in. angles, one 14 × ¾-in. cover plate.

What will seem strange to many is the inability of most of our present shops to give those who are coming along the general knowledge that should be obtainable. Yet this is readily understood by experienced superintendents or foremen of heavy-work foundries, for in all such shops the ordinary founder or molder, although he may work a lifetime alongside the leading man, can never be brought half to realize what experience, skill, judgment and caution are requisite in order to make a man one to be recognized as a leader in the art. It is chiefly to the principles of heavy founding that we must look for the education of any desiring a thorough knowledge of the art of founding; and the more varied the knowledge they have of the principles underlying work in green sand, dry sand and loam molding, the more thorough they will be, and the better fitted to assist in protecting and advancing the art of founding.

It will be noticed that an understanding of the principles involved in founding, and not the possession of experience, is cited above as aiding the founder to achieve desired results. Of course, if we can possess an understanding of principles, combined with experience, the better qualified we are for understanding and following the pursuits of the founder or molder. It will seem strange to those inexperienced in founding to be told that a founder or molder can be experienced in doing actual work and still lack knowledge of the principles involved in the art or the work they may have in hand; but it is the fact, and there are many examples. What successes such founders and molders had were greatly due to their imitating those gone before, whose knowledge had been obtained largely by sad and expensive experience. These, in many cases, could have been avoided had the founder or molder understood the principles involved in the work at hand. It is here that the value of foundry literature is displayed.

But that these books may do the greatest good, it is necessary to have opportunities whereby the principles of founding can be exhibited in actual workings. Some may advise a novice or student to secure opportunities in one of the few general casting shops. This would work very well, providing instructors could be obtained who understood the principles of the work they were doing, and had the ingenuity to originate methods of teaching them; but, as explained above, founders and molders, as a rule, have depended more upon shop experiences than upon a study of the underlying principles in attaining what proficiency they possess. For the man who aims to be a proprietor, general manager, chemist or designer of foundry work, it is very essential that he should understand the principles involved in scientific and commercial founding. If this cannot be obtained in the shops of general foundries, then I would suggest that colleges fit up so as to give opportunities for instruction in the science and art of founding, as they do in machine shop or blacksmith work.

What is required of colleges at the present day is that their course in foundding be so laid out and systematized as to impress upon the student in a lasting way what is practical and meritorious in all that pertains to general founding. Then, when the graduate passes through a foundry in after-life, his equipment will be such as to give him a fair understanding if work is being properly done or when trouble arises, to assist in devising remedies. The evils of the present methods of college instruction in founding are similar to those of the specialty shop, in that it affords but a smattering of what is true founding, and results in the same injury to the trade that is now found on every hand by reason of the general lack of a more thorough knowledge of broad founding. In college instruction it is not necessary that castings of every character or of any great weight should be made. What is wanted is a course of instruction which will demonstrate good and bad results by different methods in the molding of green sand,

*Sharpsville, Pa.

dry sand and loam work castings, with explanations for both conditions, to be followed by illustrations of the principles involved.

It is for the best interest of the trade that every means be used to induce the practical man to become a capable manager of the mixing of metals by analyses and a master of cupola work, as well as of the floor. The foundry which is compelled to divide such responsibilities is lacking in internal harmony and economy of production as cited in the beginning of this paper. Such advancement for the practical man need not injure the technical man's chances of congenial and remunerative occupation, for there is room for him at the top as president, consulting or designing engineer or chemist. For in any of these positions, when thoroughly conversant with the principles of scientific founding, he cannot but be of greater value to his firm, and success will be more pronounced when he is seconded by the practical foundry superintendent or foreman, who always prefers to be under the supervision of a president or general manager possessing some practical knowledge of founding.

Discussion.

The discussion of these two papers was taken up at the same time, and was opened by Mr. West with a vigorous contradiction of Mr. Kirk's statements in favor of putting chemists in entire charge of the foundry and cupola work. He claimed that one-third of the large foundries are now successfully making mixtures by analysis rather than by grade, and pointed out that it is not sufficient for a certain quality of iron to be produced at the cupola spout by the work of the chemist, since a careless or incompetent foundryman may produce different results from those intended to be produced by the particular quality of metal in the ladle. He believed in the general technical education of the men, rather than in subordinating them entirely to the chemist. As to silicon in the iron, he denied that founders are seeking for iron free from silicon. The increasing use of steel castings is no indication that iron founding is deteriorating, but is a development apart from iron founding, since steel possesses certain qualities not possessed by cast iron. The selection of molding sand, blacking, etc., could not be made by analysis with any practical success; the molder must see and feel it and use his judgment as to its suitability for different kinds of work. He also strongly opposed Mr. Kirk's views in favor of the rule-of-thumb method of grading pig iron by fracture, instead of by analysis, and showed that there is no certainty about this method.

Dr. Moldenke said that analysis could not show whether sand was fresh or old, or whether old sand was fit for use. He had recently had occasion to experience this difficulty. Good judgment and practical knowledge are needed, as well as mere college education and theory. Many chemists make the mistake of looking upon chemistry as the only necessity. But the foundry chemist must have practical knowledge and close observation of cupola practice, because the varying effects of the blast, the proportion of scrap, and many other details have an important influence on the character of the iron. The metal in the cupola may be of the right heat, a too hot or too cold, and will make a different kind of iron in either case, although the mixture may have been prepared with great care by the chemist.

Mr. McDowell stated that he had made extensive investigations as to the influence of silicon, phosphorus and the other metalloids in cast iron, with a view of grading pig iron in this way, so that the molder and furnaceman can know just what they want to produce an iron of a certain quality (Eng. News, Feb. 3, 1898). As to the education of the men, he thought there was a tendency to regard the molder as a man of lower intelligence than a machinist, but he thought this to be entirely wrong, and that these men should have as good a chance of technical education as machinists now have. The Western Foundrymen's Association has endeavored to get some technical institution to take up this matter. Another member said that in his experience the boys in machine shops and pattern shops are much more eager in attending night schools and in studying books than are the boys in the foundry, besides which the latter rarely stick to the molding. Some training schools have a molders' shop and a cupola, where the boys are taught the practical work of founding, but when they leave they are in demand for the drafting office or other department on account of their practical knowledge. Whether they became molders or not, he thought the practical training could not but be beneficial.

ANNUAL CONVENTION OF THE AMERICAN FOUNDRY MEN'S ASSOCIATION.

The fifth annual convention of this association was held in Chicago, June 5, 6 and 7, the headquarters and place of meeting being at the Great Northern Hotel. The first meeting opened about 11 a. m., June 5, when a representative from the mayor's office delivered a brief address of welcome. The President, Mr. J. S. Seaman, read the annual address, which was brief, and referred to the satisfactory and thriving condition of the industry, and to the great development in making steel castings. The report of the Secretary, Mr. John A. Penton, referred at some length to the increasing use of molding machines. It also showed that the receipts of the association during the past year amounted to $2,135; expenditures, $1,902; balance, $223.

Standardizing the Testing of Cast Iron.

The progress report of the committee on this subject was read by Dr. Richard Moldenke, showing that comparatively little progress had been made, owing to the phenomenal activity of the trade. The work, however, has already attracted wide attention in Europe as well as in this country, and one member of the committee has been appointed on the special work of the American section of the International Association for Testing Materials. The tests made during the year were on 48 bars of cold-blast charcoal iron for heavy chilled rolls, and 44 bars of warm-blast charcoal iron for large sand rolls. Transverse tests only were made, and none of the bars were machined. The tests were made by the Pittsburg Testing Laboratory and the Riehle Bros. Testing Machine Co. The analyses of the 1-in. dry sand test bars and some of the results of the tests are given below:

	Cold-blast.	Warm-blast.
Total carbon	2.36	3.04
Graphite	.06	none
Silicon	.85	.72
Manganese	.15	.17
Phosphorus	.482	.454
Sulphur	.07	.07

	Cold-blast.			Warm-blast.		
	Breaking strain, lbs.	Deflection, ins.	Contraction, ins.	Breaking strain, lbs.	Deflection, ins.	Contraction, ins.
Green sand, 1 × 1 in.	2,810	.270	..	3,070	.218	..
" " 4 × 4 ins.	174,400	.140	.12	168,640	.140	.11
" " 1.13 ins.*	2,460	.290	..	2,310	.215	.17
" " 4.51 ins.*	201,020	.100	.11	128,980	.150	.12
Dry sand, 1 × 1 in.	2,250	.200	.27	2,450	.220	.18
" " 4 × 4 ins.	185,600	.220	.11	140,540	.170	.11
" " 1.13 ins.*	2,410	.230	.24	2,330	.210	.18
" " 4.51 ins.*	196,320	.150	.11	169,340	.170	.11

*Diameter.

Report of Bureau on Standard Drillings.

The second annual report of the standardizing bureau of the Association was read by Mr. Thomas D. West, and showed that up to May 19, 1900, the associations' standard drillings had been adopted by 149 laboratories, of which 140 are in the United States, 3 in Canada, 2 in Germany, 2 in Australia, 1 in England and 1 in Nova Scotia. The total expenses up to date have been $519, while the receipts for drillings sold amounted to $765.

A great obstacle to be overcome in introducing these standards was the doubtful practice of different chemists making their own standards. It had to be shown that such procedure failed signally in obtaining a uniform set of standards for universal exchange. To demonstrate this, Mr. West prepared special samples of drillings from pig iron and sent them to 20 chemists for analysis, with a view of learning how close they would agree. At the time of the publication of the results, some critics claimed that the great variation of the analyses was wholly due to the imperfection of the samples. So many chemists believed this to be the case that it caused Mr. Edmund E. Johnson, then chemist of the Ashland Iron & Steel Co., to get up what he thought a perfect sample, as an offset to Mr. West's supposedly imperfect one, to distribute to chemists for a comparison. Samples of Mr. Johnson's drillings were sent to 50 chemists, and brought results that were just as variable as those obtained by Mr. West, as can be seen by the table below. These variations prove more than any other thing can the value of standards created by our ablest experts and distributed by one central agency:

	Sil.	Sul.	Phos.	Mang.	C.C.	G.C.	T.C.
Mr. Johnson's*	.19	.028	.029	.19	.34	.82	.48
Mr. West's*	.21	.015	.031	.23	.59	.77	1.09

*Variation.

The committee has published this table with a view of emphasizing the practical value of its work and as an argument for continuing the good being done until all laboratories come to recognize the necessity of possessing the standards distributed by the Association's bureau. From the progress being made, it looks as though the day was not far distant when this will have been accomplished. The variations shown are not so much due to the character of either sample, but rather to the lack of tangible means to detect errors in the results. This, unfortunately, is still a weak point in the chemist's profession, and, instead of feeling aggrieved at the great disagreement of results in either Mr. Johnson's or Mr. West's report, efforts should be made to remove all objectionable conditions so that greater uniformity in analyses may result. This the American Foundrymen's Association Standardizing Bureau is now helping to do.

Technical Education for Foundry Work.

At the afternoon session, two papers on technical education in foundry practice were read and gave rise to an interesting discussion. The first paper was on "The Training of Foundry Chemists," by Dr. Edward Kirk, favoring the putting of chemists in charge of foundry work; the second was on "Training Students in the Principles of Scientific and Commercial Founding," by Mr. Thomas D. West, favoring a general education for foundry foremen and superintendents. Abstracts of these papers, with the discussion, are given in another column. Following this, the association passed a resolution adopting the suggestion made in a memorial from the Pittsburg Foundrymen's Association, to the effect that institutions of learning should be requested to provide special education for the positions of foundry managers, cupola men, etc. This should include technical education in its broadest sense, with good business training, and might be provided by enlarging the regular course in metallurgy to include cupola practice and foundry work.

The Mixing and Melting of Iron for Hydraulic Work.

This was the subject of the next paper, by Mr. R. P. Cunningham, of Holyoke, Mass., and dealt with the manufacture of castings to stand hydraulic pressure. Unless the right kind of iron is obtained, to form castings of a close and dense texture, the castings will leak under pressure.

Castings used in hydraulic work must be sound, close-grained, and free from shrinkage. Only those who have had experience in this class of work know how difficult it is to accomplish. The exact chemical composition required in iron to produce the above castings should be determined and lived up to closely. It is often necessary to analyze your iron for the four principal elements, for it is a well-known fact that iron high in silicon is low in sulphur; and when silicon is low, manganese is low and sulphur is high. In foundry irons you must watch the silicon, phosphorus and manganese in order to obtain satisfactory results. In summing up, your mixture should contain from 1.25 to 1.50% silicon; from 0.40 to 0.80% phosphorus; from 0.40 to 0.60% manganese, and sulphur as low as possible. If you will take that for your standard, and melt your iron hot, you will see a decided improvement in the quality of your castings.

Crystallization of Metals.

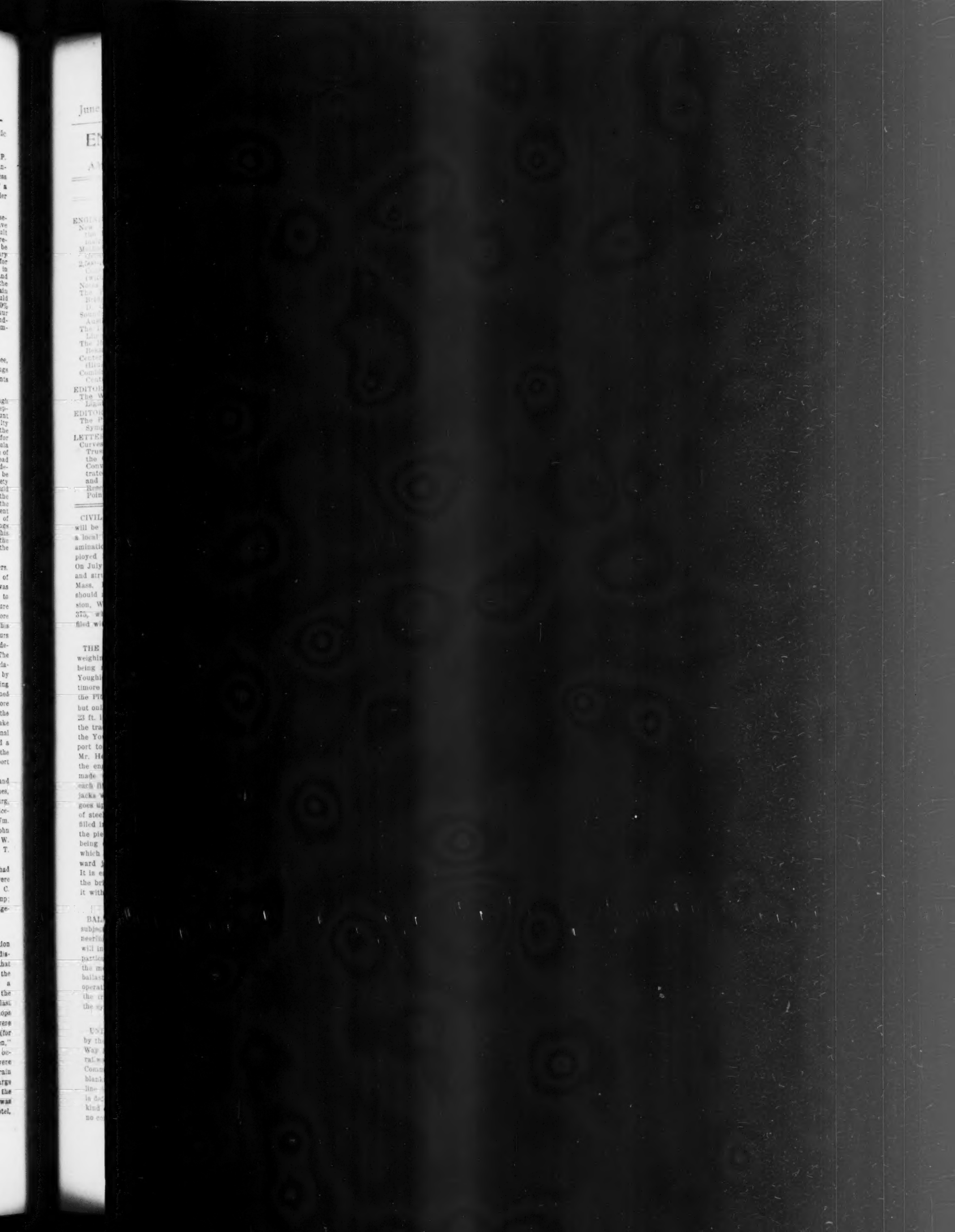
This paper, by Mr. Edward B. Gilmour, of Milwaukee, Wis., dealt with the necessity of so designing castings as to avoid weakness due to unsymmetrical arrangements of the crystals at corners, etc.

If the crystals are united in regular order all through the casting, without any weak planes caused by the separation of the crystals, and which only occur on account of defective designs, a casting is at its strongest. Faulty designs have been a source of great trouble to the founder, and in a great many instances he is blamed for putting inferior iron into the castings. A regular formula has been used by the designer, who calculated that iron of such dimensions was strong enough to carry the load required, and did not allow for crystallization. If the designer is familiar with these laws, the founder will be saved much money and time; also a great deal of anxiety and trouble. The molder before pouring his work should be cautioned to look after his iron and see that it is of the required temperature to suit the work. The heavier the piece is the cooler should it be poured, as the development of crystals depends upon the regularity of the cooling of the casting, and dull iron always makes stronger castings because the crystals are better defined. However, this does not always make clean castings, so that after all, the molder has got to use discretion in order to produce the best results.

There was no discussion on either of these papers. The next business meeting was held on the morning of June 7. As to the place of the next convention, it was suggested that the Executive Committee be requested to consider the advisability of holding it at some pleasure resort, where there would be less distraction and more opportunity for the reading and discussion of papers. This was a reasonable suggestion, since only about three hours out of the three days' convention at Chicago were devoted to the papers and reports on the program. The advisability of abandoning the "Journal" of the Association (on account of the amount of information given by the trade papers), and, on the other hand, of enlarging this publication, was discussed. The president explained that it is proposed to have the same papers read before the several local associations, and then to collate all the discussions in the "Journal." It is also proposed to make the local associations branches of the main or national association, instead of being entirely independent, and a committee was appointed to prepare an amendment of the constitution for this purpose. This committee will report at the next annual meeting.

The nominating committee then made its report, and officers were elected as follows: President, W. A. Jones, Chicago, Ill.; Secretary, Dr. R. G. G. Moldenke, Pittsburg, Pa.; Treasurer, Howard Evans, Philadelphia, Pa.; Vice-Presidents, G. B. Buckingham, Worcester, Mass.; Wm. Yagle, Pittsburg, Pa.; J. P. Golden, Columbus, Ga.; John A. Penton, Detroit, Mich.; Wm. Ferguson, Chicago; W. S. Mosher, Dallas, Tex.; R. Chartrey, San Francisco; T. J. Best, Montreal.

The following papers were on the program, and had been printed in advance, but were not taken up, and were not even read by title: "The Real Fuel Ratio," L. C. Jewett; "What Are Improvements," Paul P. Ramp; "Foundry Flasks," Eli H. Pearce; "Foundry Management," James A. Murphy.

Entertainments.

By far the greater part of the time of the convention was devoted to sightseeing and entertainments, to the disappointment of some of the members, who considered that more time should have been given to the papers and the general business of the association. On Wednesday a large party went by the steamer "Soo City" to visit the South Chicago works of the Illinois Steel Co., the blast furnaces of the Iroquois Iron Co., and the yards and shops of the Chicago Shipbuilding Co. At these yards were three very large freight boats, two still on the stocks (for launching sideways) and one, the "Robert E. Bunsen," afloat and receiving its finishing touches. This trip occupied the whole of the day, and theatre tickets were provided for the evening. On Thursday, a special train on the Atchison, Topeka & Santa Fe Ry. took a large party to visit the Drainage Canal, going as far as the controlling works at Lockport. In the evening there was a "smoker" and vaudeville entertainment at the hotel, which ended the convention.